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NEW YORK SEATTLE

MOTORSHIP

Devoted to Commercial and Naval Motor Vessels

"MOTORSHIP" is entered as second-class matter at the Post-office at New York, N. Y., U. S. A., July, 1918, under the Act of March 3rd, 1879.
Office of Publication, 1270 Broadway, New York, N. Y.

Issued Monthly
PRICE 25 CENTS
Domestic, $3.00 per year
Foreign, $3.50 per year

APRIL, 1921
Vol. 6 No. 4

EXCLUSIVE motorship-operating and technical articles by the world's foremost writers on marine engineering appear in every issue.

MOTORSHIP

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PROFUSELY illustrated with photographic reproductions of the newest designs in international merchant motorship construction.

Vol. VI New York, U. S. A., April, 1921 No. 4

"Buenos Aires" in New York Harbor

Many American Shipping-Men Visit Interesting Swedish Motorship at Personal Invitation of Her Owner—Some Plain Facts Concerning Why She Came Over Fully Loaded, and Returned Fully Loaded with U. S. Products When Hundreds of American Steamers Are Idle

By THE EDITOR

Consul-General Axel Johnson

ONE obstacle to rapid development and adoption of the Diesel-engined motorship in America has been the persistent reluctance of shipowners to inspect visiting motorships. At various times dozens of invitations to visit domestic and foreign motorships in New York Harbor have been sent to shipping-men in New York, but in nearly all cases the absence of executive-officials at these inspections has been conspicuously noticeable, they in the majority of cases having pleaded pressure of other business, and have delegated their superintendent-engineers or other representatives to attend in their place, instead of personally accompanying their engineers and seeing for themselves the benefits of motor-power. Surely the fact that a single motorship can effect annual economies as large as $300,000.00 makes a personal visit more important than the average business a shipowner may have had to transact at that particular moment—often a ship-owner will spend hours with fellow directors figuring how a thousand dollars can be saved in some other direction. Pleas of urgent business affairs, or that they would not understand what they saw because of non-technical experiences, are merely evasions which we believe can only be due to shipowners not seriously believing in the reliability of the modern motorship or in the enormous economies to be effected by their adoption. Therefore, this is no time to use soft phrases to indicate the position, as the American shipping situation is getting too serious.

A direct contrast of such attitudes is paramount at the moment in the case of a leading Scandinavian shipowner who, although swamped with his own urgent business affairs, devoted the final few hours of his extremely busy time in New York to making such a visit to his newest motorship possible to American shipowners, thus facilitating their knowing what his company was doing in the shipping-world, what advances they are accomplishing, and with what degree of success. That his ships are in competition with American vessels increased the importance of this inspection, and incidentally demonstrated the fine feelings prompting him.

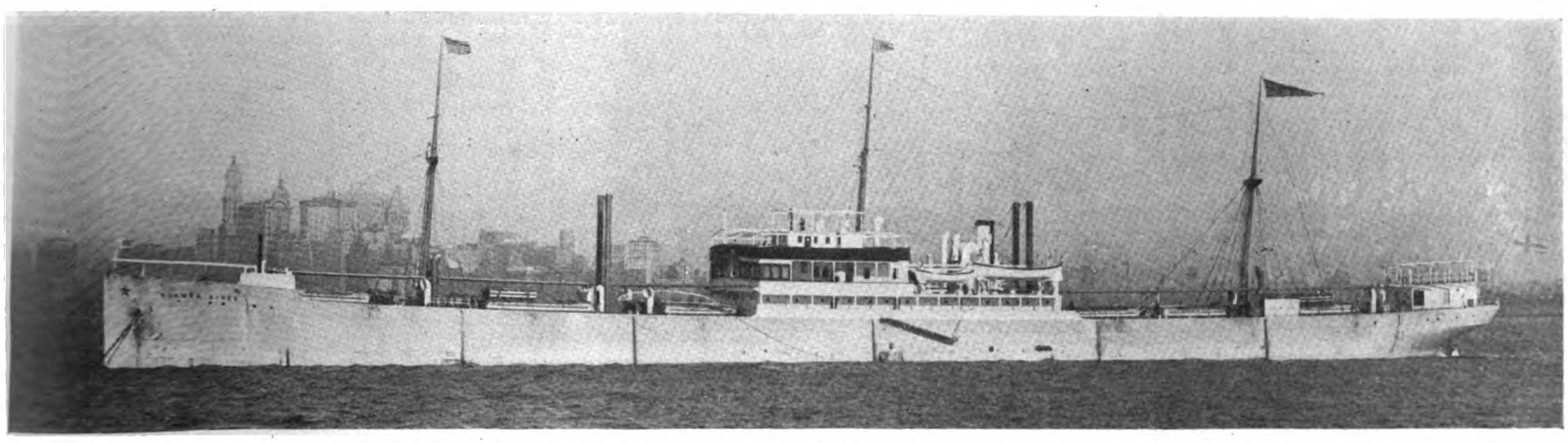
After a few weeks in the United States, studying oil-fuel conditions, and the general shipping business, Consul-General Axel Johnson, managing-owner of the Johnson North Star Line (Nordstjernan) of Stockholm, Sweden, was mystified as to why American shipowners still continue to build oil-fired steamers when it is the ideal country for Diesel-driven motorships because they will help conserve the available oil supply. That such a waste of valuable oil should be continued, he thought, is terrible. He also was astonished to find how little the directors and executives of American ship-operating companies know about motorships and Diesel power, particularly as his own line of motorships show economies and additional earning powers on the Sweden-South America-San Francisco route of over $150,000.00 per round trip per ship, or about $300,000.00 per annum, the saving in fuel being enormous. There can be no questions regarding reliability, he said, as the first of his fleet—the m.s."Suecia" had been operating for eight years and had never had any machinery trouble. Mr. Johnson is a believer in the direct-Diesel drive, and has no faith in electric-transmission in preference because there is at once 12 to 15 per cent less in economy, and knows that the present slow-speed engines are quite reliable, and have ample flexibility of operation. But he thinks the oil turbines now developing in Germany have quite a future.

In order to convince American shipowners of the reliability and economy of the Diesel-motorship as it stands to-day, and as an obtestation against the building of oil-fired steamers, Mr. Johnson courteously sent an invitation—at no little inconvenience to himself—to about one hundred leading shipowners, shipbuilders and bankers to visit his new vessel "Buenos Aires" on Saturday, February 19, on which vessel he started the same evening en route for Sweden. In sending this invitation he showed a most broad-minded spirit, because he realized that unless America adopts similar type of craft and converts large numbers of existing uneconomical steamers, it will be impossible for our merchant-marine in its present condition to compete against his motorship fleet.

As an instance to support this contention, his own Diesel-vessel "Buenos Aires" passed down New York harbor loaded to her Plimsoll mark with American products, passing by hundreds of American coal-burning and oil-fired steamers swinging idly at their moorings—laid-up because of high-cost of operation and absence of cargoes. On her voyage from London to Pernambuco (en route to San Francisco via the Straits of Magellan), her deadweight-capacity was 10,250 tons, or even higher than on this return voyage, so she has been fully loaded every trip since placed in service. Practically all the Johnson line of steamships are now laid-up, they running motorships almost exclusively while the present shipping slump lasts. So far as we are able to ascertain, there isn't an ocean-going, steel Diesel-motorship laid-up to-day anywhere in the world for want of cargo or for high cost of operation, and work on the completion of new motorships is going ahead in the face of cancellations of steamship contracts.

We regret to say that of the shipping-men invited only about 30 attended personally. About thirty sent representatives, and half-a-dozen were unable to attend through absence from town, while the others did not trouble to acknowledge the invitation. We are bringing this delicate matter to the light of day in this manner, because it is necessary to bring home the fact that the present condition of our mercantile marine is partly due to the indifference of shipping executives to the really vital factor of ship operation; namely, economy! Nevertheless, those present came ashore feeling that their time was more than well-spent. Among those present were Frank Munson of the Munson S.S. Line, and Wm. Thompson of the Texas Co. It is to be hoped that those shipowners who missed the opportunity afforded them will visit the next available motorship.

Consul-General Johnson and Captain E. Atterling



Johnson Line Diesel-motorship "Buenos Aires" anchored off New York City. Her owner Consul-General Axel Johnson is so appalled at the terrible waste of oil under the boilers of American ships that he invited about one-hundred American shipowners and shipbuilders aboard in order to convince them of the success of Diesel propulsion, and that it is practically impossible for American steam ships to compete with his motorship fleet. Over fifty of those invited were aboard.

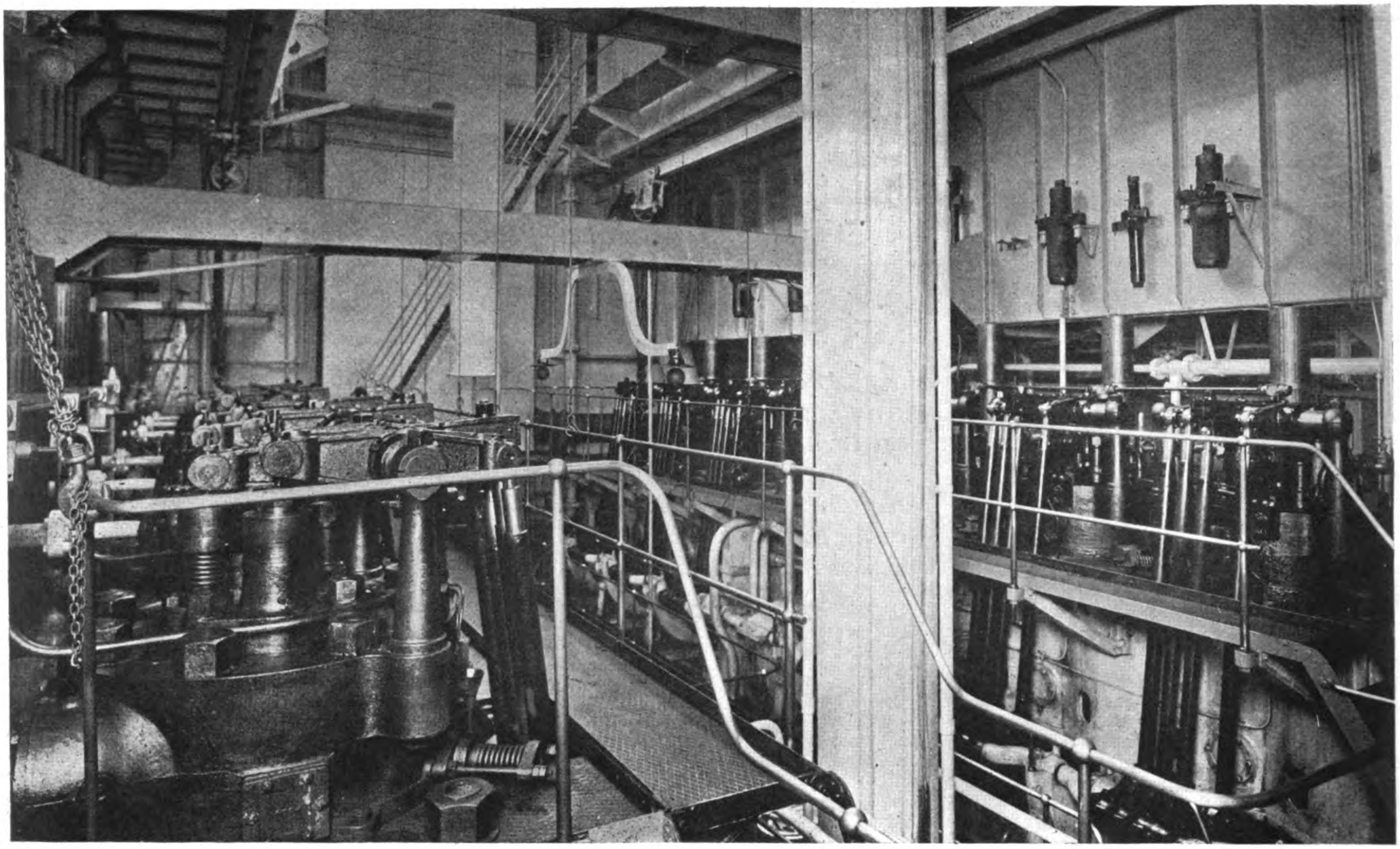


Photo by Morris Rosenfeld

Engine-room of the m. s. "Buenos Aires" the day she arrived at New York from San Francisco. Note the perfect order and cleanliness. Not a single repair was required.

personally received the guests, who after inspecting the ship were entertained to a delightful light luncheon. The Ekstrom brothers, New York agents of the Line, kindly arranged for a tug to transport the visitors to and from the ship, and acted as marshalls. The m.s. "Buenos Aires" was anchored off the Battery where she had arrived the previous evening from San Francisco via the Panama Canal. We are greatly indebted to Mr. Johnson and the others for their kindness and courtesy.

The Johnson Line fleet of motorships consists of the following vessels:

Name	Deadweight Capacity Tons	Power I.H.P.
"Suecia"	6,550	2,000
"Pedro Christophersen"	6,550	2,000
"Pacific"	6,550	2,000
"Kronprinzessan Margareta"	6,550	2,000
"Kronprinz Gustaf Adolpf"	6,550	2,000
"San Francisco"	6,550	2,000
"Valparaiso"	6,550	2,000
"Lima"	6,550	2,000
"Balboa"	9,350	3,100
"Buenos Aires"	9,350	3,100
"Canada" (recently delivered)	9,350	3,100
Building	6,500	2,000
Building	6,500	2,000
Building	6,500	2,000
Total 14	99,950	31,300

In addition to these motorships they own and operate a large number of steamers built before they had tried-out the Diesel system of propulsion. These steam craft they intend to convert to Diesel-machinery as soon as is feasible, with the exception of a few which will be retained in their present form. Meanwhile, as just stated, the steamers are now laid up. An article on their m. s. "Kronprins Gustaf Adolf," which was placed in service in January 1914, appeared in "Motorship" of July, 1919, when complete details of her auxiliary machinery were also given.

Many of the above fleet were built by Burmeister & Wain of Copenhagen, but the "Buenos Aires," "Balboa" and "Canada" were constructed by the Götaverken, of Göteborg. The most excellent construction of the hull, machinery and accommodation was remarked upon by the engineering section of those invited aboard. To ourselves the "Buenos Aires" is of special interest as we were in Göteborg the day she was launched in September, 1919, and this was the first time we had seen her since then.

Photo by Editor of "Motorship"

Consul-General Johnson and Captain Atterling watching the arrival of the visitors on the tug.

Her leading capacities are as follows:

Loaded displacement (this trip).......13,800 tons
Net dry and wet cargo carried this trip
(not including actual fuel)...........8,900 tons
Net cargo-capacity (not including oil-cargo
fuel, water, etc).............8,100 to 8,300 tons.
Dead-weight capacity (summer)........9,350 tons
Dead-weight capacity (winter).........9,050 tons
Cubic-capacity of holds (5)..553,835 cu. ft. (grain)
Cubic-capacity of holds (5)..506,080 cu. ft. (bales)
Fuel-capacity (maximum).............1,622 tons
Fuel carried this voyage...............1,500 tons
Gross tonnage (British)...............5,524 tons
Net tonnage (British).................3,380 tons

Here it should be mentioned that about 800 tons of this fuel-oil practically represents cargo and is disposed of such in Sweden, so her net cargo-capacity exclusive of fuel, water and stores for a round trip from Sweden to San Francisco and return is about 9,000 tons, on a displacement of 13,800 tons. This should be compared by American ship owners with the net cargo-capacities of their own oil-fired steamers of similar dimensions over a similar route. It will be found that the "Buenos Aires" carries from 1,000 to 1,200 tons more money-earning cargo. The draught with this load is 25 ft. 11¾ in. Her dimensions are:

Length (O.A.) ....440 ft.
Length (B.P.) ....425 ft.
Breadth (Md.) ....56 ft.
Depth ....30 ft. 38 in.
Depth of hold.........................16 ft. 9 in.
Mean draught (on this voyage)........26 ft. 8 in.
Co-efficient 0.76
Passenger accommodation,
12 first-class and 2 second-class

After the capacities for the dimensions have been compared with those of steamers the powers, speeds and fuel-consumptions should be considered, namely:

Designed power.......................3,100 i.h.p.
Power actually averaged.......3,100 to 3,400 i.h.p.
Designed engine speed.................125 r.p.m.
Engine-speed actually averaged.......124½ r.p.m.
Designed speed ....11½ knots
Speed actually averaged (fully-loaded).11¼ knots

Designed daily fuel-consumption........10¼ tons
Actual daily fuel-consumption..........10¼ tons
Daily fuel-consumption in port............¾ ton

Few steamships follow their designed specifications so closely as this in actual service, so the foregoing results may be considered excellent and speak volumes for the reliability of her Diesel propelling machinery.

Regarding her loaded sea-speed, on this voyage from San Francisco to Stockholm she had aboard 8,000 tons of grain, several hundred tons of case-goods such as dry fruit, and 1,500 tons of fuel-oil, the latter reducing to 1,250 tons by the time she reached New York. She also stopped at Acajutla and took aboard 50 tons of cargo. So it may be said that her average dead-weight capacity (including drinking water and stores) was about 9,600 tons throughout, making allowances for the consumption of fuel. This, of course, is higher than her rated d.w.c., but according to her owner her maximum d.w.c. is 10,250 tons. At this load her net dry and oil cargo capacity must be about 9,600 tons without including fuel, etc.

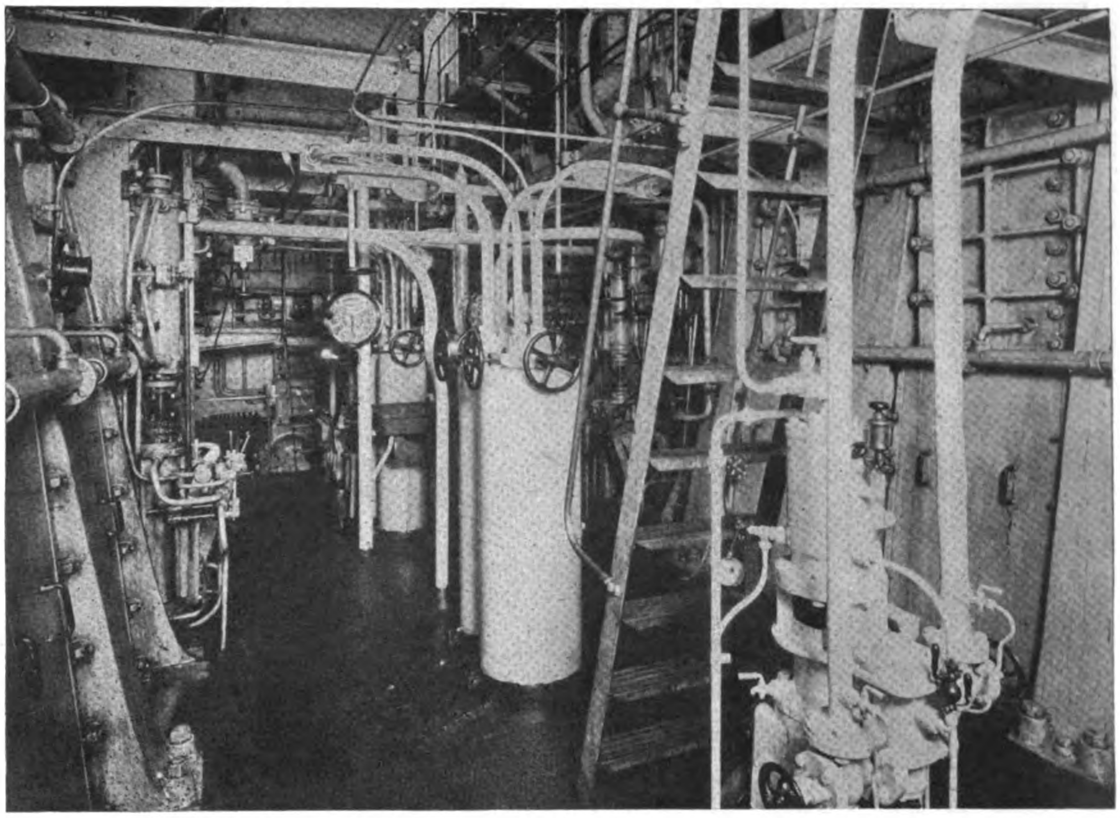
On the chief-engineer's desk was the log of the last ten days of the trip. The average daily speeds were recorded as follows: 10.63 knots; 10.95 knots; 11.04 knots; 11.20 knots; 11.28 knots; 11.24 knots; 11.28 knots; 11.49 knots, and 10.92 knots. The speed of 11.25 knots generally averaged is attained on a daily consumption of 10¼ tons of fuel (0.308 lb. per i.h.p. hour) and with the twin engines together indicating 3,100 i.h.p. at 124½ revs. per minute.

But the speed of 11.49 knots average was secured by running the engines at 126.9 and 126.3 r.p.m., respectively, together developing 3,400 i.h.p. on a daily fuel-consumption of 10.35 tons of fuel-oil, or 0.311 lb. per i.h.p. hour.

This is sufficient answer to those who dispute the fact that the i.h.p. hour consumption of Diesel-engines in service does not exceed 0.35 lb. and who doubt that the consumption is only one-third of that of the average oil-fired geared-turbine drive. For instance, in a recent speech before the National Merchant Marine Association, Mr. Joseph W. Powell, ex-vice-president of the Bethlehem Shipbuilding Corporation, erroneously declared that the saving of oil on a 10,000-ton ship was only 12 tons per day, or $100.00.

Owing to Chief-Engineer Emil Hallengren being swamped with questions by other visitors we were unable to secure a complete log for the entire round trip of the ship, which was her maiden voyage.

Next for comparison with a steamer comes the engine-room crew. The "Buenos Aires" carries a total of 14 men, namely, chief-engineer, second, third and fourth engineers and 10 greasers. No electrician, donkey-man or firemen are carried. The engineers attend to the electric motors, etc., and to the donkey-boiler.



Main-engine control-floor of the engine-room of the m. s. "Buenos-Aires."

Then comes the question of fuels. Already Chief-Engineer Hallengren, has been making some interesting experiments, with a view to eventually running entirely on Mexican crude-oil if necessary, or if the resulting economy is sufficient to warrant the step. Mixtures of heavy crude-oil and Diesel-oil were tried as follows:

Percentage of Mexican crude	Percentage of Diesel-oil	Increased Consumption
⅔	⅓	2%
½	½	1½%
⅓	¾	½%

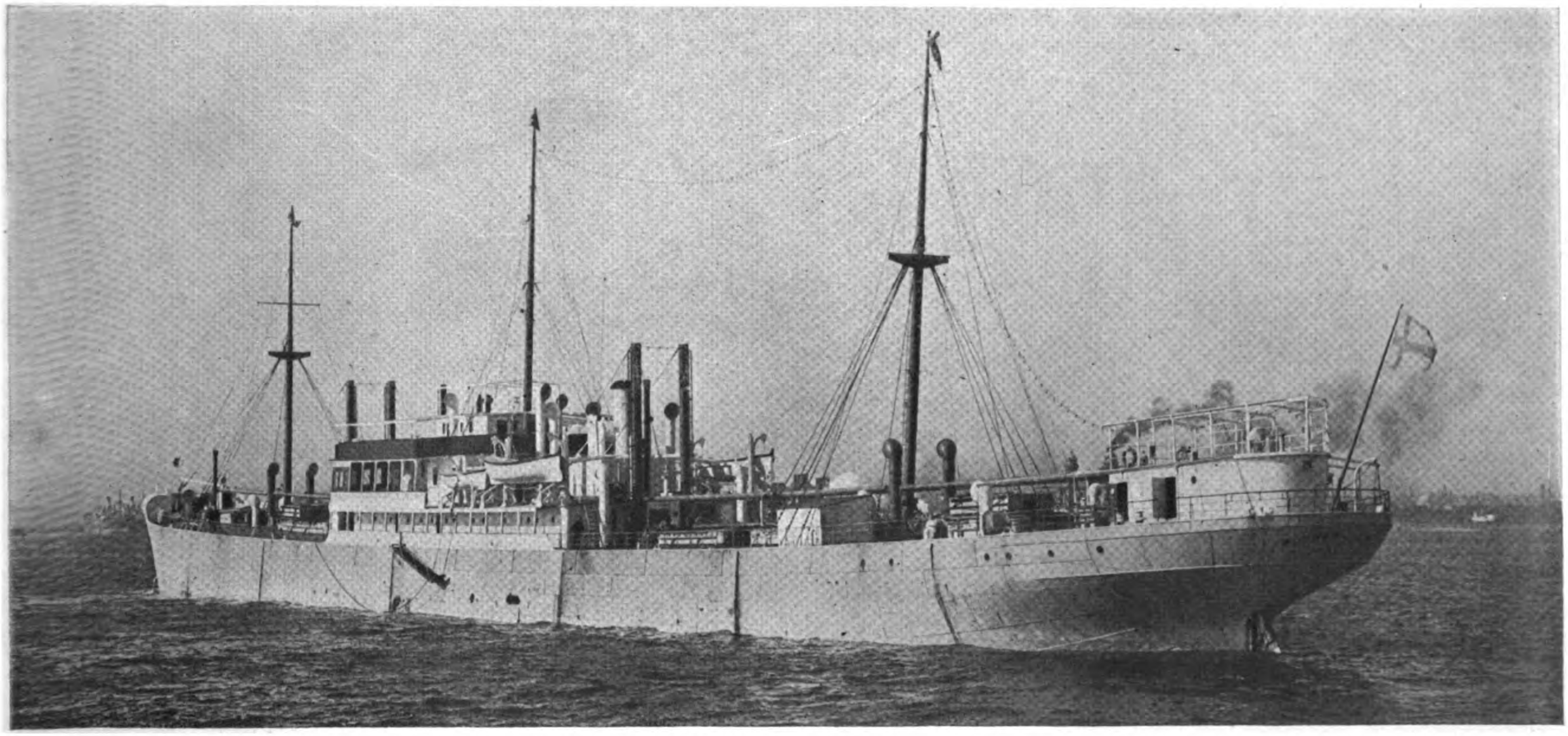
From the above results we estimate that if all Mexican crude-oil were used, without the mixture, the consumption would be 3% higher than when burning Diesel-oil solely.

But, shipowners have to bear in mind that the total daily consumption of fuel with a motor ship of this size is so low that the difference in fuel-bill is very small, and to-day Diesel-oil can be obtained in almost any leading port in the world, also a Diesel-vessel can carry at least four months' supply without interfering with her cargo capacity.

For instance, the "Buenos Aires" uses approximately 10 tons per 24-hour day. To-day this quantity of Mexican crude-oil would cost about $155.00. If she used Diesel-oil her fuel-bill would amount to about $200.00. Thus by using boiler-oil the daily saving is approximately $45.00 less 3%, and the question at once arises, is it really worth while, in view of the economies already effected compared with steamers?

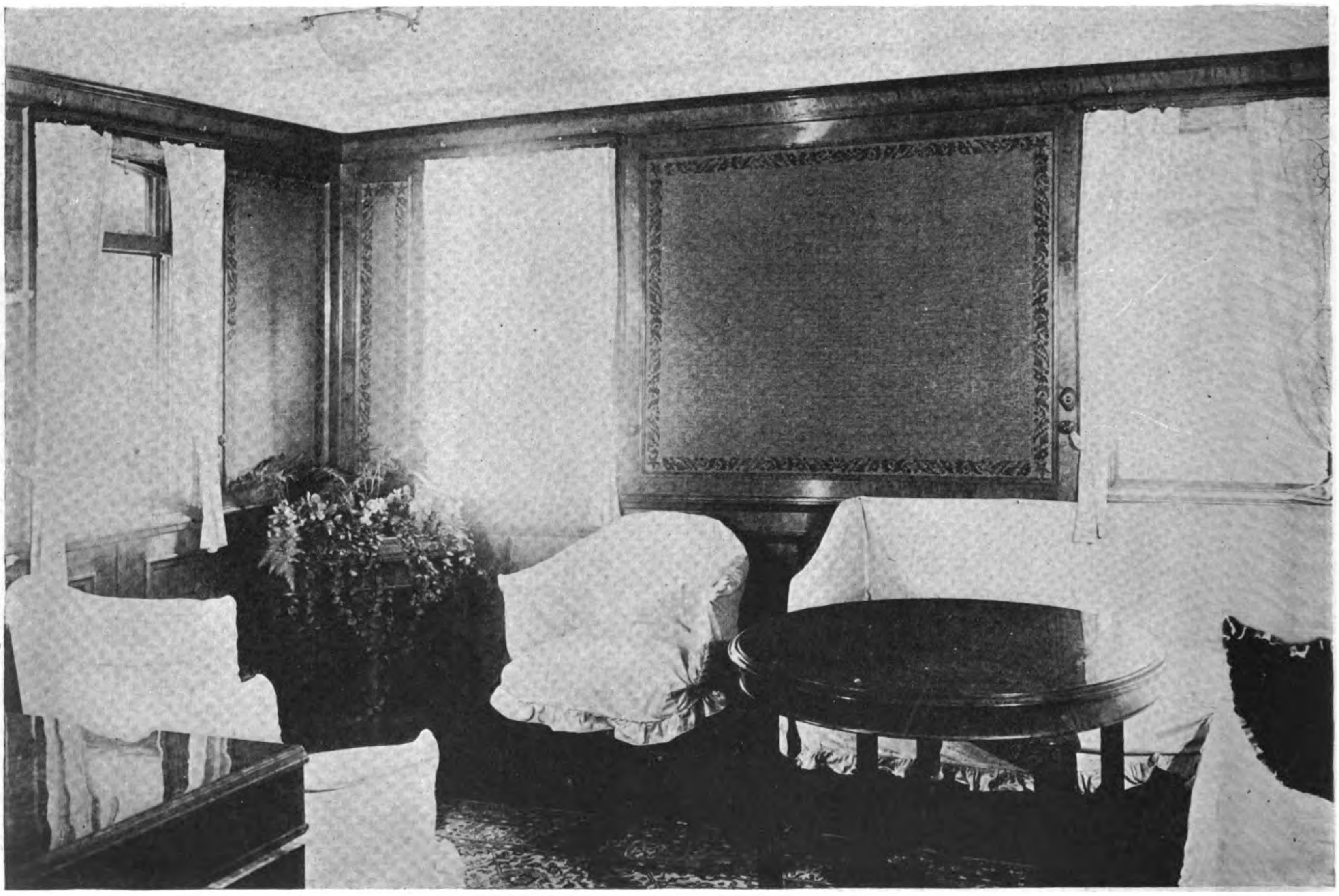
The argument that motorships should be able to use regular steamer-oil is not so important as claimed by opponents because of the following reasons:

(A) Saving is comparatively slight.
(B) Motorships are not dependent upon overseas bunker-stations, but can pick-up oil where it is cheapest.

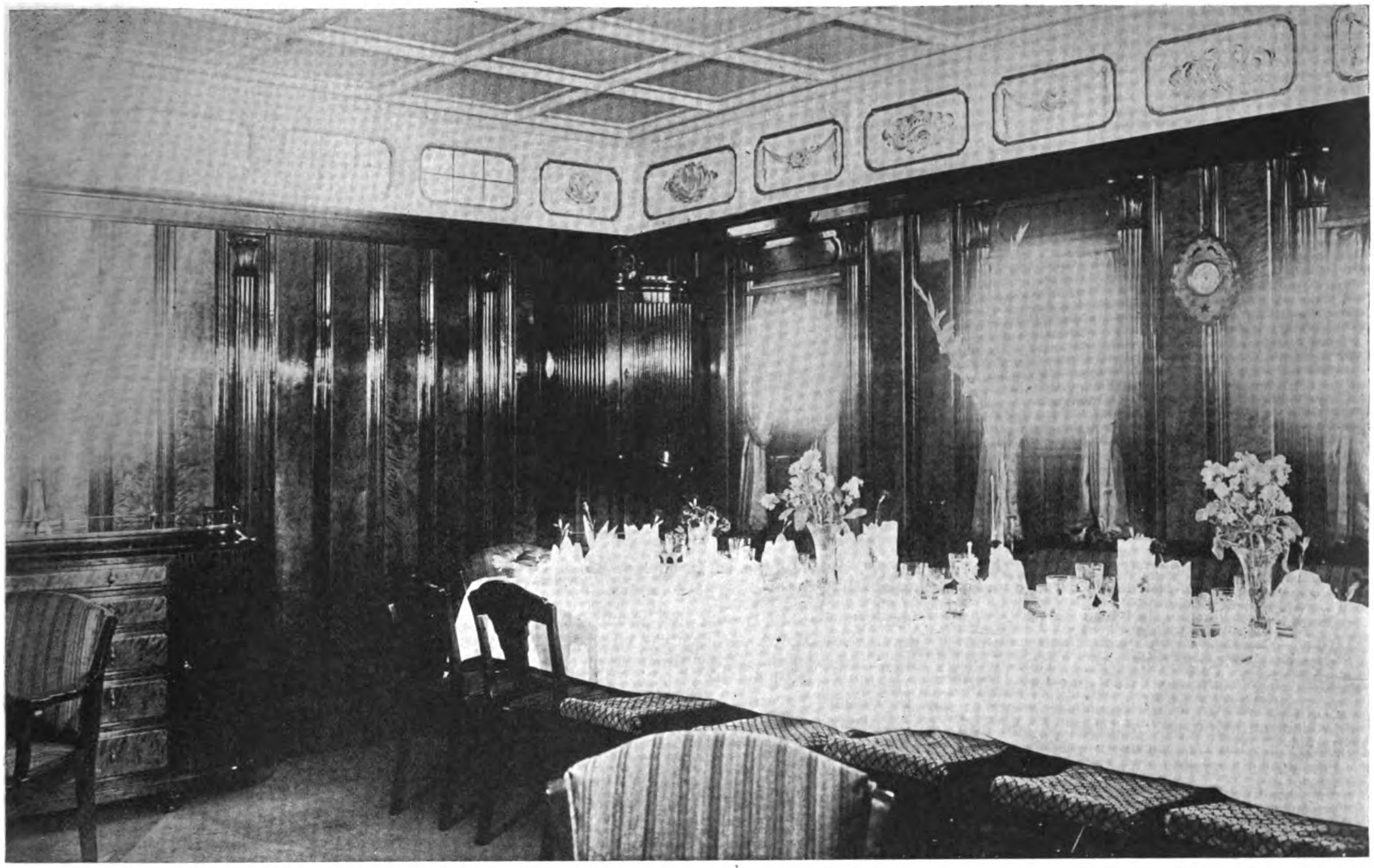


"Buenos Aires" leaving N. Y. for Sweden fully loaded with American products on Feb. 19, 1921. On her way down the harbor she passed numbers of uneconomical American oil-fired and coal-burning steamships laid-up because of no available cargoes and because of high cost of operation. The m. s. "Buenos Aires" will go to Sweden and back without costing a cent in fuel-oil.

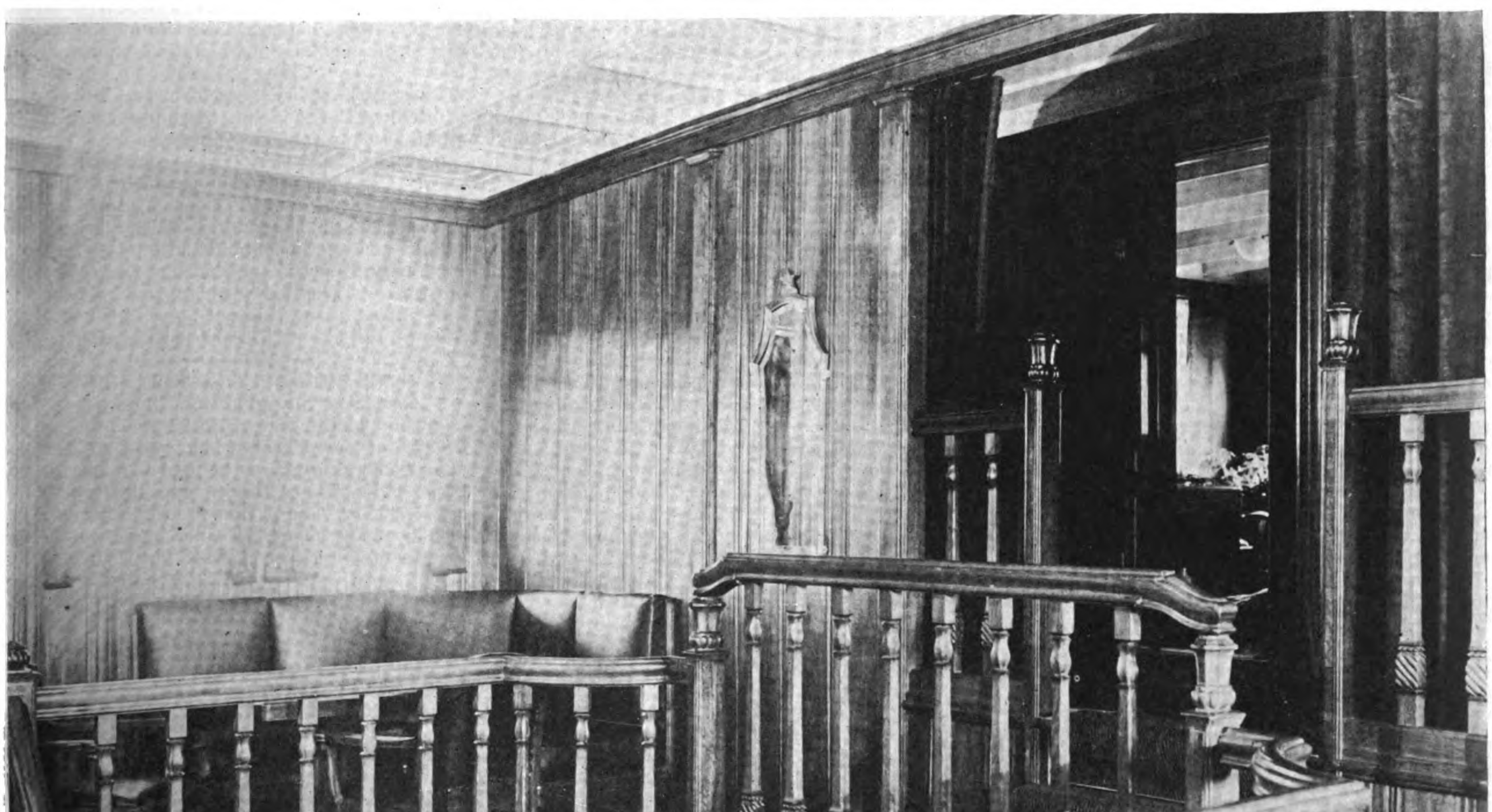
A corner of the smoking-lounge of the "Buenos Aires."



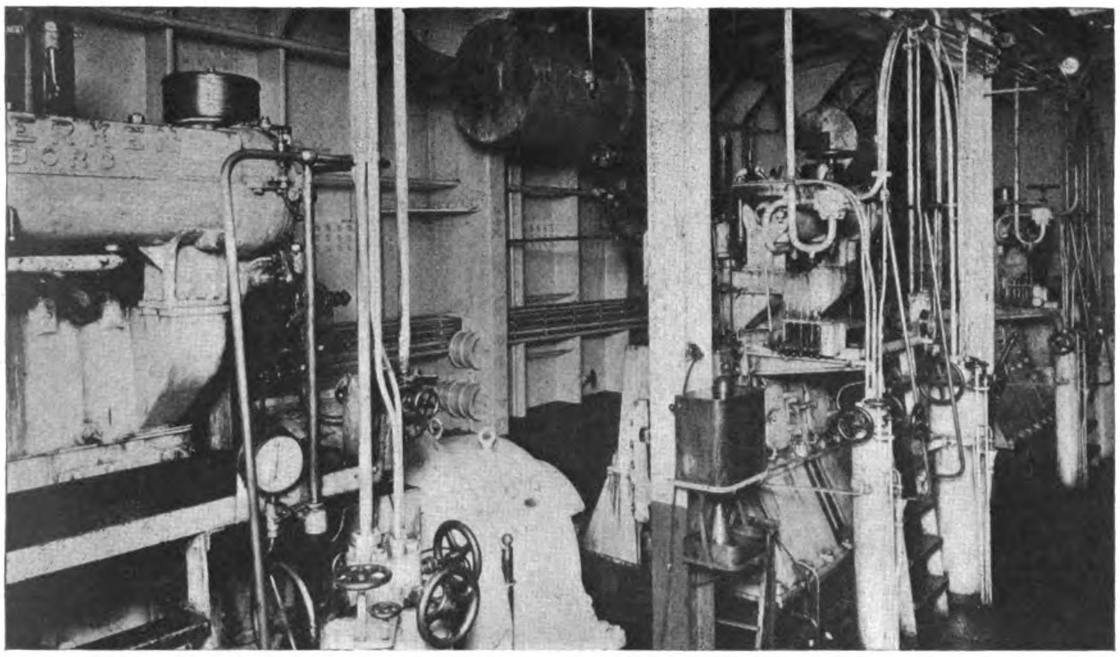
Owner's lounge on the Diesel motorship "Buenos Aires."



Dining-saloon of the Johnson Line's motorship "Buenos Aires" where Consul-General Axel Johnson entertained over fifty American shipping men.



Stairway and cosy-corner of the Diesel motorship "Buenos Aires."



Port side of engine-room of the m. s. "Buenos Aires" showing the three 90 h.p. Diesel-electric generating-sets for operating the auxiliaries of the ship.

(C) Need only bunker two or three times per year, unless selling part bunker-oil as cargo in Great Britain, Scandinavia, France or other countries that have little or no natural fuel-oil.

(D) When called upon, motorships can use heavy crudes if same are heated by steam generated by exhaust-gases, although the use of crude-oil means more work for engine-room crew.

(E) Grade of fuel advisable largely depends upon skill and conscientiousness of engineers-in-charge.

(F) Using Diesel-oil (solar-oil) on motorships engaged in U. S. A.-Europe service has certain benefit of its own, because there is always a steady demand for this class of oil for new motorships leaving Europe on maiden-voyages, also because need of this oil for cleaning gas in large city gas-plants. This enables surplus bunker-oil to be sold at prices much higher than those paid.

Therefore, the question of grade of oil-fuel should be decided by the particular requirement of every individual ship and her route. For instance, let us take the particular case of the "Buenos Aires." At San Francisco she took aboard 1,500 tons of Diesel-oil contracted for at a fairly low rate by her far-sighted owners (every American shipowner should be in the position to do likewise). She arrived New York with 1,250 tons, and needs about 375 tons to go to Stockholm and back to the Panama Canal, leaving a surplus, after making all arrangements for emergencies, of over 800 tons which will be sold as oil-cargo in Sweden. This fuel cost about $20.00 per ton at San Francisco while to-day the market price in Sweden is about $43.00 per ton. This means that her bunker-load of fuel cost $30,000.00. The 800 tons surplus fuel-oil which she will sell in Sweden, either to sister ships or to other concerns, will bring about $35,000.00, so that the vessel has absolutely no fuel-bill whatever.

Here would appear to be a case, where the use of a good grade of residual-oil fuel is a distinct gain to the shipowner, as in addition to giving the owners of the "Buenos Aires" the opportunity of avoiding a fuel-bill, there seems to be a good chance of making about $5,000.00 in addition. These figures, of course, are worked out by ourselves, but are based on the consumption and fuel-cost figures given us by the owners. Nevertheless, it will be seen that the motorship brings many new conditions of operation into being, all of which should be studied by the shipowner in all its phases, and properly weighed and balanced. We do not suggest that crude-oils should not be used, but that there are sides to the question which must be thoroughly probed.

Even if the motorship could not sell her surplus Diesel fuel-oil, her fuel-bill for one year with oil at $20 per ton would not exceed $25,000. If she burned steamer fuel-oil at $15 per ton, her annual fuel-bill would be about $18,500, or a saving of $6,500. Hence we once more suggest that shipowners satisfy themselves as to the advisability of using the lower grade oil unless necessary for other reasons.

There can be no doubt but that when more ship's engineers are trained in the operation of Diesel-engines heavier fuels will be more generally used on motorships. But, without American motorships, American engineers cannot be trained, except in the builders' shops while the engines are being constructed, which is the policy adopted in Europe. Even at the present time, however, there can be no question but that two-cycle type of engine will use many heavy grades of Mexican and Texas oils. To shipowners whose ships operate to the Far East, we suggest that Taraken crude-oil be used whenever it can be obtained. This is a heavy-oil that is cheap in the Dutch East Indies, and which makes excellent Diesel-fuel if warmed to a fluid state.

We must mention that on one motorship Chief-engineer Hallengren was the only experienced marine Diesel-man in the engine-room, as owing to influenza his entire engine-room staff were sick, leaving the chief the sole operator for three days. He prefers men without Diesel experience, as it is a much easier matter to train them to his views on successful methods of operation.

As yet we haven't said much about the machinery of the "Buenos Aires." She is propelled by twin Götaverken-built Burmeister & Wain type four-cycle Diesel-engines, each with six cylinders 630 mm. (24.803 in.) bore by 960 mm. (37.795 in.) piston-stroke, and they are installed about amidships. Each develops 1,550 i.h.p. at 125 r.p.m.

For auxiliary power everything is electrically driven. There are three two-cylinder four-cycle B. & W. type Diesel-engines of 120 i.h.p. (90 b.h.p.) coupled to 60-K.W., 273 ampere, 220-volt electric-generators, built by the Almanna Svenska Elektrisk A/B, of Vesteras, Sweden. They are arranged on the port side of the engine-room. One is in operation all the time, two when in port working cargo, and the third is a stand-by. Each burns half a ton of fuel-oil per 24-hour day at full load. So when in port one engine operates for 12 hours and the other for 24 hours, giving a combined daily consumption in port of ¾ ton.

The small oil-fired donkey boiler at the after end of the engine-room is for steam-heating the ship. It has a diameter of 1,350 mm. by 3,150 mm. length, with a working pressure of about 45 lbs. Generally speaking, the auxiliary machinery in the engine-room follows the arrangement of other B. & W. type motorships completed during the last few years, the plans now being practically standardized. For instance, at the forward end of the engine-room there is a battery of four rotary-type lubricating-oil pumps, driven by two 220-volt electric motors. On the starboard side is a planer, and a lathe, the electrically-driven auxiliary air-compressor, bilge and general service pumps, etc. On each main Diesel-engine there is a 5 b.h.p., 220-volt, 25-amp. electric-motor for turning over the engine. It operates at 375 r.p.m. and is geared to the engine-shaft.

To manufacturers of pressure-gauges who are not yet fully acquainted with Diesel motorship construction, we will mention that we counted no fewer than 42 pressure-gauges in the engine-room of this vessel. So there is an excellent market available for such instruments.

There are 12 derricks on deck and six hatches, worked by twelve 3-ton electric-winches and by one 5-ton electric winch. There is no deep-tank to the ship, the double-bottoms having a capacity of 1,323½ tons of fuel, and 298½ tons of fuel are carried in the wing tanks. Also, in the double-bottoms, wing-tank, fore peak and after peak tanks, ballast-water to the total of 2,028 tons can be carried when the ship is light. As yet she has not needed this feature. The electric-winches were constructed by the Almanna Svenska Elektriska A/B, but the electric steering-gear was made by John Hasties & Co., Greenock, Scotland.

Consul-General Johnson stated that before the war the cost of a similar motorship in Scandinavia was about $50,000 more than that of a steamer, but to-day the cost is about 10% higher than the price of a steamer.

However, we desire to point out that the cost of a motorship is really less than a steamer if we take her net cargo-capacity as a basis, instead of the obsolete and misleading deadweight-capacity tonnage, because the motorship carries about 12% more cargo per ton of steel used in the construction. As already indicated, when the "Buenos Aires" is loaded to a displacement of 13,800 tons, no less than nine-thousand tons represents profit-earning cargo. Whereas, with an oil-fired steamer of similar dimensions loaded to 13,800 tons displacement not more than 7,700 tons would represent dividend-earning cargo especilly if she was carrying fuel for this long voyage from San Francisco to Sweden and return.

Shipowners who believe that motorships are more costly to construct because American Diesel-engines are 30% higher than steam machinery, will do well to bear this in mind. They can make their motorship smaller in size, and consequently cheaper, and still carry as much cargo as the steamer, while the overhead, operating, insurance and depreciation charges will be less.

Designers, as well as owners, hitherto have overlooked the fact that the net cargo-capacity of an oil-fired or coal-burning steamer is very much limited by the distance of the voyage (which is hardly the case with a motorship), so to lift the same net-cargo as the "Buenos Aires" on a voyage of 7,000 to 15,000 miles, the hull of a steamer would have to be from 10% to 14% larger, and the engine-power fuel-consumption, dues, proportionately greater. Shipbuilders bidding on vessels should point this out to shipowners.

THOS. ORCHARD LISLE.

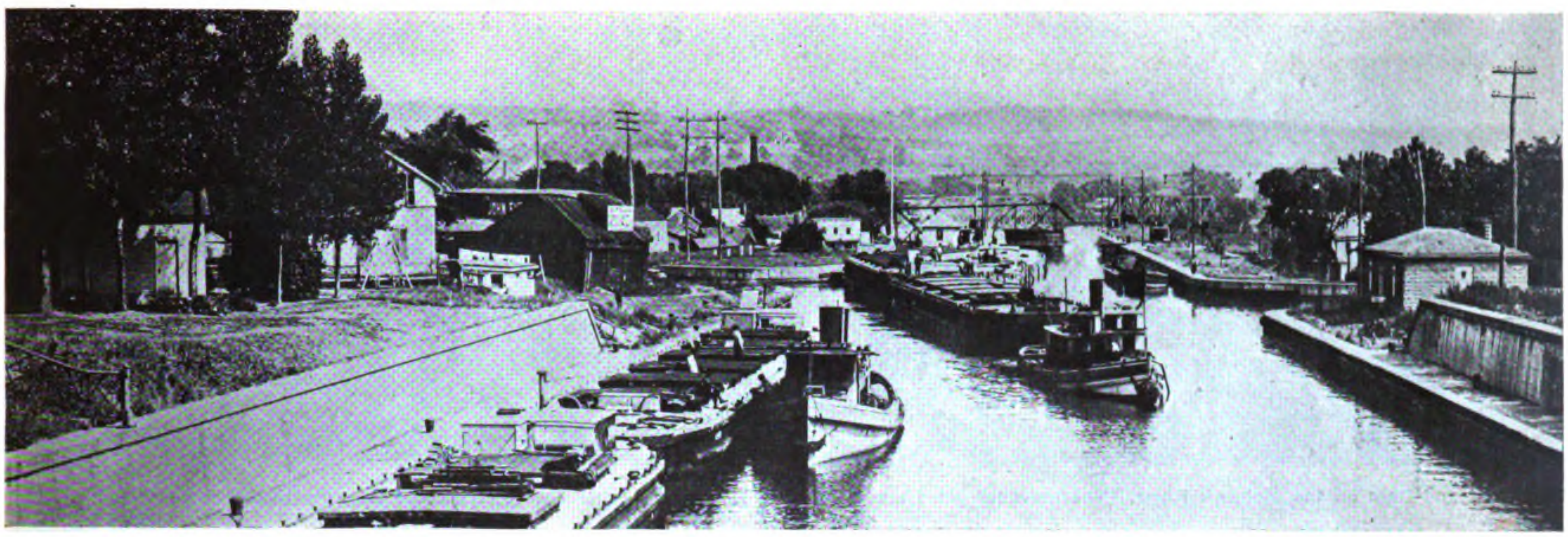
FUEL-BILL OF THE "STUREHOLM."

A clerical error crept into the article on the operation of the motorship "Stureholm" on pages 206-207 of our March issue. The total fuel-consumption was given as being 1,142 tons at an average of $5.00 per barrel, and the total fuel-bill as $5,712.50. The latter figure, however, is obviously incorrect as $5.00 per barrel is $35.00 per ton, so that the cost of 1,142 tons at that average price would be about $39,970. We had inadvertently taken the price per barrel as the cost per ton when multiplying.

Nevertheless, the "Stureholm's" actual fuel-bill probably was lower than this, as of each bunker-load of 1,000 tons taken aboard in the U. S. A. she can, if desired, sell about 600 tons in Sweden and still have enough fuel to return to the U. S. A. And there is a steady demand for this class of fuel-oil in Scandinavia for motor-vessels and for cleaning gas at town gas-works. Furthermore, the prices actually paid by the "Stureholm" for oil varied from $17.50 to $45.50 per ton, and to be on the safe side we took $35.00 per ton as an average, whereas it probably was less than this. So a total fuel-bill of $25,000.00 is probably nearer the mark.

PROPOSED STATE TAX ON FUEL-OIL

A measure has been introduced in State legislature providing for tax of 1c per gal. on all liquid-oils used in internal-combustion engines in the State of Washington.



Lock No. 3 at Waterford, N. Y. The tugs are burning-up fuel while waiting for lockage. Oil-engine power can be instantly shut-down and immediately started, without waste of fuel during the interim.

Economical Transportation on the New York State Canal

A Series of Exhaustive Articles on Barge-Commerce Along the World's Greatest Inland Waterway

BY OUR SPECIAL COMMISSIONER

PART II—The Structures and Boat-Handling Equipment of the New Canal

[Continued from page 202, March issue. Owing to the printer's devil being particularly active last month, pages 200 and 201 were accidentally transposed, so page 201 should be read before 200.—*Editor.*]

FEW people realize that the New York State Barge Canal suffers not at all by a comparison with the Panama Canal. Whereas the latter has cost $400,000,000.00 and required 200,000,000 cubic yards of excavation, the modern New York State waterway will have incurred a bill for $200,000,000.00 and necessitated carving out 115,000,000 cubic yards. 5,000,000 cubic yards of concrete have been poured on the Isthmus and 3,000,000 in New York State. In order to cope with a far more diversified range of technical problems, the Barge Canal engineers had to build 39 dams and 57 locks, while at Panama only 4 dams and 6 locks were necessary. The Panama Canal is 50 miles long, less than one ninth the extent of New York's 454-mile watercourse. More than half of the entire Adirondack watershed had to be impounded and controlled to meet its needs.

Because of a variety of unsettled conditions originating in the later history of the old Erie Canal and because of circumstances arising out of the World War, a direct comparison on a commercial basis is not now possible. Among other things, floating equipment is sadly lacking on the New York State Barge Canal; but inasmuch as an adequate supply of this would only represent something like a quarter of the entire physical basis of canal transportation, it is a certainty that commercial development must take place as the result of present necessities and because three quarters of the physical basis—a stupendous civil engineering accomplishment—is already complete and functioning perfectly.

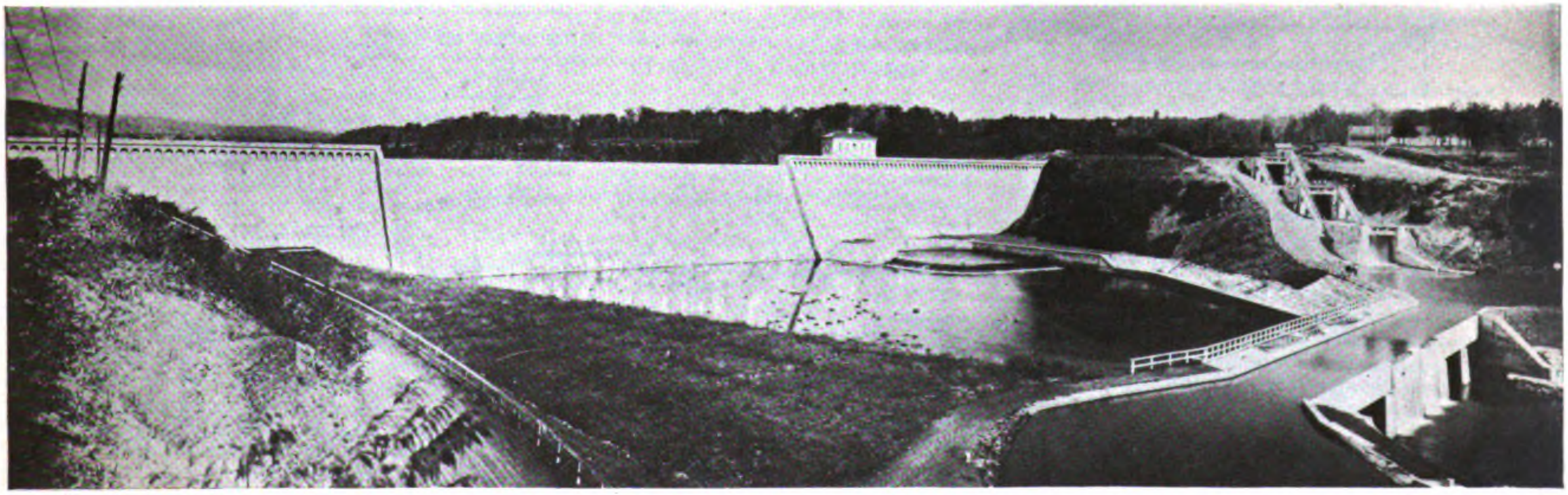
Before the modern New York State Canal was begun in 1904, traffic on the old Erie waterway had dwindled away at a steady rate. Although competition by the railroads had something to do with this, the facts of the matter fall far short of supporting the assumption that railroad rate cutting killed the old canal.

The growing inadequacy of floating equipment, a self-intensifying cause of canal decline, was a much more vital factor. Lack of boats was due originally to uncertain and halting action on the part of the State as regards enlargements and to the consequent unwillingness of entrepreneurs to commit themselves on types that might be rendered unfit because of State action. As old boats rotted away, fewer replacements were made, and the resulting damage to the service made it less and less attractive for any one to be bothered with it all. Owing to the lack of elevator facilities at New York City, canal-boat shipments labored under a severe handicap as compared to the railroads, to whom the use of a few hundred thousand freight-cars more or less for storage purposes every year was of no great consequence.* The old canal was completely out of the running as regards way traffic, which could be handled at all seasons and with infinitely greater convenience by means of railroad spurs and sidings. These temporary and far-from-conclusive discouragements brought the business of canal transportation to such a pass in 1898 that the State of New York made up its mind that something had to be done.

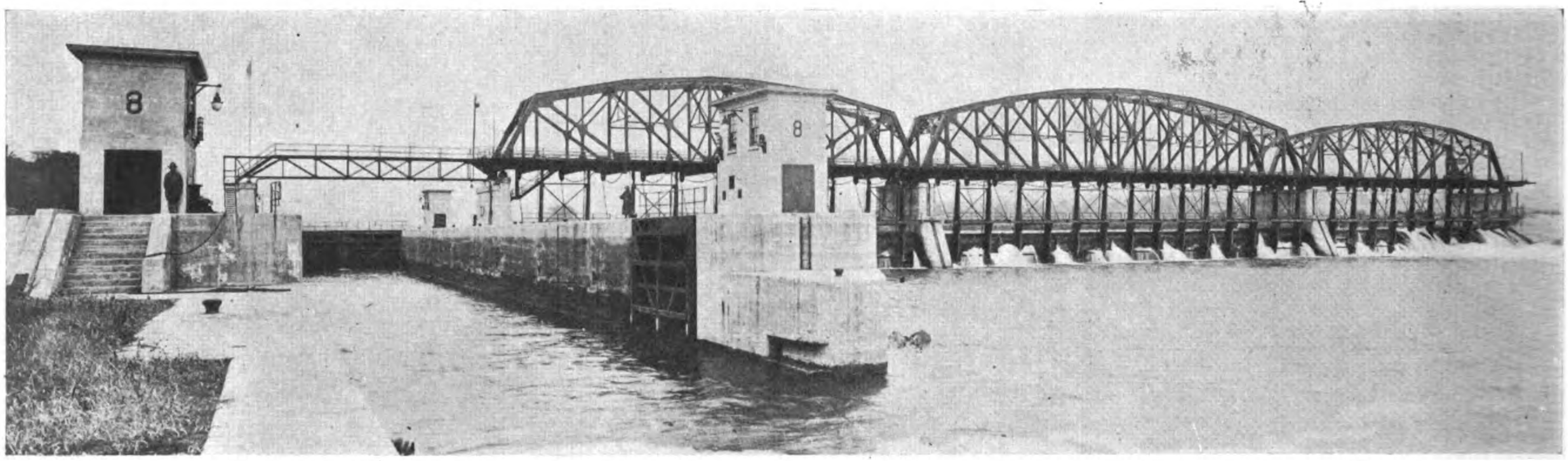
The Greene Committee was appointed by the late Col. Theodore Roosevelt in 1899 to study the matter and consisted of General Francis E. Greene, Ex-Mayor George E. Greene of Binghamton, N. Y., Representative J. M. Scatcherd of Buffalo, Major Thomas W. Simons, Mr. Frank S. Witherbee of Port Henry, N. Y., State Engineer Edward A. Bond, and Superintendent of Public Works John M. Partridge. As the result of their comparative consideration of a ship canal to replace the old Erie, they found that such an undertaking would not be desirable. Its capacity for handling freight would not greatly have exceeded that of a barge canal. The cost of building ocean-going tonnage was estimated at $71 per dead-weight ton, lake freighters at $36 per ton, and canal barges at $7.50 per ton. A traffic which might require tying up equipment costing $71 per ton over a creeping lengthy voyage did not seem to offer great inducements and the $500,000,000.00 cost was prohibitive. The committee made an emphatic recommendation for what is now known as the New York State Barge Canal. They were silent on the subject of floating equipment, in the assumption, presumably, that the creation of a high-class modern waterway would automatically stimulate the design and construction of suitable boats. They did not forsee the great World War and its results.

At a referendum vote in 1903 the proposition was declared O. K. by a very substantial majority,

*In recognition of these facts, New York State has appropriated $3,000,000 for elevators at Brooklyn and Oswego.



Delta Dam, on the upper Mohawk River north of Rome. This superb structure impounds 2,750,000,000 cubic-feet of water to feed the locks of the New York State Barge Canal.

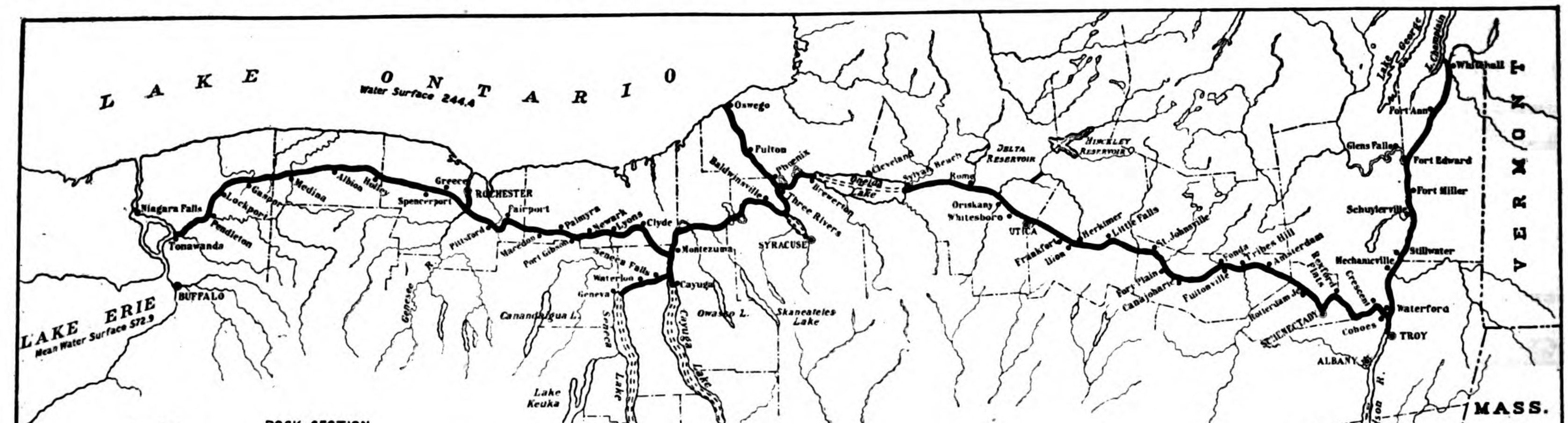


Lock and Dam on the Mohawk River. The movable gates are in operation, regulating the flow of water to suit the needs of the New York State Barge Canal.

and as a result of this $101,000,000.00 were appropriated. Since it took about a year to make the plans and let the contracts, actual construction work was not begun until the spring of 1905. Three years later an additional $8,000,000 began to be devoted to a project for connecting up Cayuga and Seneca Lakes with the modern canal system, an undertaking which seems at first glance to fly in the face of early canal experience. For it had been found that branch canals or "laterals" such as the Chemung, the Chenango, and the Genesee Valley tributaries, which had been opened within a few years of the original Erie's completion, could never be successful and were speedily abandoned. These lessons of history lose their validity, however, in view of the fact that the Cayuga and Seneca branches really tap the coal mining and industrial center of Pennsylvania and that through bulk traffic from there to New York City is highly advantageous in spite of the detour. Other additions to the original canal budget, notably $19,000,000 in 1914 for terminals, increased the original cost to $154,000,000 and before all the proposed grain elevators and miscellaneous improvements have been carried out, the outlay will have amounted to something more than $200,000,000.

The State engineers who started the job in 1905 had anything but plain sailing. Owing to the law which required that the old Erie canal be kept open at all times, roundabout methods had to be used and many delays had to be put up with. Another circumstance that did not contribute to a speedy prosecution of the enterprise was the fact that a large number of railroad lines had to be relocated and gave rise to protracted litigation. The greatest difficulties were those inherent in the project itself and arose from the ambitious plan to utilize the existing turbulent and seasonally erratic water-courses which the original canal engineers had so studiously avoided. Two thirds of the Erie canal were abandoned and the rivers in whose banks it had been cut were "canalized."

Wherever the route of the new canal passed through those parts of the Mohawk, Oswego, Cayuga, Seneca, or Hudson rivers whose cross-section was at any point less than 12 x 200 feet, they were modified to suit these dimensions either



The last word in Inland Waterways, but which has no vessels with the modern system of economical propulsion-machinery.

by dredging or by the construction of dams and locks. Sometimes, as was the case at Troy, a plain fixed dam could be depended upon to maintain the proper level throughout all known variations in the volume of water discharged at that point by the Hudson river and to incur no risks attendant upon ice jams or freshets.

Some dams, as for instance a number of those situated on the Mohawk river, had to be made movable and adjustable, not only to take care of variations in flow, but also to permit the river to return to its natural state during periods when torrential discharges threatened the dam itself with destruction and the surrounding country with inundation. Such would ordinarily occur only during winter months during which inland navigation is stopped anyway. Elaborate bridge-like structures providing anchorage and control for massive gates had to be built and powerful electric hoisting-gear installed. All of these structures caused extensive changes in the aspect of the adjacent country and gave rise to a variety of private claims arising out of property and water-power damage.

The hydraulics of the New York State Barge Canal would fill a book. Even to persons accustomed to thinking in engineering terms, it comes as quite a shock to realize that a canal must have water in it in order to be of any use. More startling yet is the wide application of the simple principle that water won't flow up-hill and a firm adherence to these precepts is essential if we are not to lose our patience as we follow the State engineers through their complicated constructions.

From a glance at the profile of the Canal, it will be seen that as boats progress between Troy and Buffalo, they must be raised and lowered a distance of 564 feet. Every time a boat passes through locks connecting sections of the canal which are at different elevations, an amount of water equivalent to the cubic capacity of one of the locks is taken away from the upper level and must be replenished if the upper level is to be kept from going dry. Nothing would be simpler, in view of the endless supply of water in Lake Erie, if the descent from its level, (573 ft.) to the Hudson River (1.25 ft.) were uniform. But Mother Earth's bosom at Rome, N. Y., is elevated to 420 feet and water from Lake Erie could not flow to this level because of a low region of 363 ft. which intervenes in the neighborhood of Syracuse. Although Seneca Lake has an elevation of 445 ft., its long distance from the Rome summit level would make it unsuitable as a feeder even if it were not for the fact that it is cut off by the same bottom level. Water from Lake Erie would replenish the locks between Tonawanda and Syracuse and would furnish an ample supply as far as Oswego, situated on the 244-ft. level of Lake Ontario, and Lake Oneida would take care of the short stretch between Brewerton and Three Rivers.

But from Lake Oneida to Rome the Canal rises with considerable abruptness, falling again uninterruptedly until it reaches the Hudson river level at Troy. Here is a long stretcvh of 22 high-lift locks, which,if operated to anything like their capacity, require careful provision of an unfailing water supply. It makes no difference even if a large proportion of the waterway in this section consists of "canalized" rivers, which are ordinarily thought of as containing large amounts of flowing water. The draining effect of the big locks would be so great as to make the normal discharge of the various streams seem quite insignificant and it is interesting to note that the ultimate annual carrying capacity of the Canal is fixed by the number of lockages that can be artificially provided.

When a boat passes down through a flight of locks, it takes the water which it needs with it. If the locks are spaced close together, as they are at Waterford, N. Y., the filling of a given lock is taken care of with the water drained from the preceding lock and if allowance is made for leakage and wastage, it may roughly be said that it takes one lock-full of water to lower the boat down. When the individual locks are far apart, however, this approximation is no longer justified, because the water that came down through a given lock with the boat gets to the next lock considerably in advance. If some other boat just happens to be there in readiness to utilize it, well and good, but it is a practical certainty that it will not be needed just at the moment when its gets there and that it will leak through the gates slowly or run over the spillway unused.

An adequate supply of water is fed into the Rome summit level from reservoirs formed by damming up the entire southern watershed of the Adirondack Mountains. 137 square miles of this area are drained into an artificial lake behind the Delta Dam, having a height of 100 ft., inundating 4 1/3 square miles, and impounding 2,750,000,000 cubic feet of water. An even greater part of the supply comes from the Hinckley Reservoir, which has been produced by a dam 56 ft. in height. The water which runs off an area of 372 square miles is collected behind this dam in a lake that has a superficial area of 4½ square miles and stores 3,500,000,000 cubic feet.

The heavier demand on this water-supply system is made by boats that pass upward through the locks. Water that is fed into a lock with a boat floating in it near the bottom is irrevocably lost, so far as that particular boat is concerned, as soon as it has been floated into the bottom of the lock next higher up. The water goes down the flight and the boat goes up the flight, and "ne'er the twain shall meet." The more traffic there is on the canal, the greater are the chances that the discharged water will be used further along.

If we consider that for upward-moving boats each lock requires, in round numbers, 250,000 cubic feet of water to fill it and that there are 22 of them between Troy and Rome, we don't need much arithmetic to discover that the passage of a single boat or tow of barges might drain the reservoirs to the extent of five-and-a-half million cubic-feet of water. When the State Engineers first told us about the Hinckley and the Delta Reservoirs, it seemed to us as though they might be bandying about billions of cubic-feet of water in a rather irreverent manner, but they really should be pardoned. Careful estimates which they have made on the basis of the foregoing considerations and a great many more besides, indicate that the water supply to the locks can take care of an annual traffic amounting to fifteen million tons.

The construction of the locks represents a thorough job of planning and execution. Although the plan dimensions of the craft that are admitted to the locks are limited to 42 ft. by 300 ft., their actual size is 45 ft. by 310 ft. Gates weighing as much as 200,000 pounds are swung open and closed on steel pivots within thirty seconds and are in some cases locked shut against a total water pressure of more than a thousand tons. Each group of locks is fitted with two independent hydro-electric generating plants which furnish current for operating the heavy steel gates and the comprehensive machinery of the movable dams.

Hand-operation is also provided, against the rare contingency that both turbines might be out of commission simultaneously. There is a single lock near Glens Falls with a lift of 40½ feet, a height considerably in excess of the greatest lift employed at the Panama Canal. The total lift of all the locks on the Isthmus is exceeded more than twice by the world's greatest flight of locks situated at Waterford, N. Y. There are five in the series and their combined lift is 169 ft.

A minimum depth of 12 ft. is maintained not only above the sills of the locks, but also throughout the remainder of the Canal. As may be seen from the sections, a minmum bottom width of 75 ft. is maintained in the "land lines." To allow for currents and other uncertainties incident to navigation on canalized rivers and lakes, 200 ft., almost three times as much, of clear channel are provided.

Where the canal has been cut through solid rock, its walls are practically vertical and enclose a passage 19 ft. wider than that of the land line, or 94 feet. in all. The extra width of the rock section is good insurance against damage that might occur to boats as the result of bottoming. Owing to the varied character of the rock which had to be cut, and particularly to the flinty nature of that which was encountered near the center of the State, a variety of expedients for removing it had to be resorted to. Drilling within dry cofferdams, underwater blasting, and the use of a 16-ton drop-hammer for breaking the rock were some of the methods devised by the State Engineers.

A complete story of the great engineering work that has been carried out would fill volumes and libraries; as we can barely skim over the subject here, and as our special purpose is to show what part should and will be played, in the final fruition of the huge effort, by the modern oil-engine, we refer those of our readers who are interested in further details to the many and excellent works that have already been published. Notable among these is an article by Mr. Wilfred H. Schoff in the Bulletin of the American Geographical Society, Volume XLVII. The comparative diagrams of the various historical cross-sections which we showed in our March issue, page 202, were borrowed from one of Mr. Schoff's articles. The curves relating to growth of population and real estate values were taken from the Historical Supplement of the Report of the State Engineer and Surveyor for 1905. This is a most exhaustive work and deserves high commendation.

A conclusion which even our fragmentary review of the vast engineering structures of the New York State Barge Canal forces home upon us is that this elaborate waterway is no place for steam-driven craft. The length of the new Canal with its branches and tributaries is 454 miles and it has 57 locks. This means that for each average clear sail of 8 miles lasting an hour and twenty minutes, a quarter of an hour must be spent in locking and unlocking. Twenty percent of the time is therefore spent in consuming a very substantial amount of fuel to no purpose whatever. Although the stand-by losses incident to the operation of steam locomotives are highly burdensome, they cannot compare to the inroads on the coal-pile made by firing coal under the boilers of tugs and power-barges that have to wait around for a fifth of the time during which they are in service. Even in the face of this handicap imposed on steam-barge operation, railroad rates have in the past continued to bear a relation of several hundred per cent to Canal freight rates.

There is nothing speculative about what Canal competition would do to the railroads, no matter what facilities they might offer, if fleets of economical motor-driven craft were put on the Canal. Railroads have maintenance, overhead, interest, and depreciation charges to meet on their right-of-way; not a penny of these costs needs to be borne by Canal transportation enterprises. The competitive margin on which the railroads have been able to do business against Canal traffic has been convenience of service and freight-handling facilities, and that has been effective against steam-driven Canal craft. The enormous economies effected by means of the modern oil engine not only in the matter of stand-by losses, but also as regards steady operation, can easily pay for differences in service facilities.

JULIUS KUTTNER

(To be continued in May issue of "Motorship")

CHICKASAW MARINE DIESEL ENGINE

It is reported that the Chickasaw Shipbuilding Co. of Mobile, Ala., is building a large four-cycle type marine oil-engine. This yard is a subsidiary of the U. S. Steel Corporation.

CHALONER'S TREATISE ON AIR INJECTION OR MECHANICAL INJECTION

In the last column of Mr. Chaloner's article on "Air Injection versus Mechanical Injection" on page 133 of our February issue some paragraphs of type were accidentally interposed by the printers in wrong places. Correcting same Mr. Chaloner writes as follows—

"My manuscript finishes on page 9 with the paragraph, which you print in column III on page 133—"again a question of dimensions of the spray-holes, which are larger when employing steam as the"—On the third line of column III page 133 you continue with the word "medium", although my manuscript commences on page 10 with the words—"atomizing agent, thus enabling larger sized holes to be used and reducing the risk of choking . . ."

Your printers interposed from line 3 to line 23 of column III, page 133, several paragraphs, which are in the wrong place, and then with line 24 come back to the correct sequence of the manuscript, which still deals with "Atomization", whereas the way you have printed it, it appears to refer to "Vaporization".

According to my manuscript, the chapter on "Vaporization" follows the last paragraph in column III on page 133; i. e.—the one ending—" . . . and impracticable when evolved in conjunction with mechanical injection."

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MOTORSHIP

Trade Mark, Registered

Published Monthly in the Interests of Commercial and Naval Motor Vessels and for Recording International Progress of the Marine Internal-Combustion-Engine

Head Office: 1270 BROADWAY, NEW YORK, N. Y.

149 California Street, San Francisco 71 Columbia Street, Seattle, Wash.

Cable Address—Freemote New York

Copies of "Motorship" can be secured from the Atlas Publishing and Distributing Co., London; from Smith and Wyman's railway bookstalls in Great Britain; also from Julius Springer of Berlin.

Published by MILLER FREEMAN & COMPANY

MILLER FREEMAN....President
THOS. ORCHARD LISLE....Editor
A. M. S. Naval Engineers. A. M. I. Marine Engineers
RUSSELL PALMER....Manager
GEO. F. FARRAH....Advertising Manager

Subscription rates: U.S.A. and Mexico, $3.00 per year. Germany, 300 marks. Canada and foreign countries in the postal union, $3.50. Single copies, United States, 25c. Great Britain, 1/6. Other countries, 35c.

"Motorship" is published on the 25th of the month prior to date of issue, and all changes in and new copies for advertising must be in the hands of the publisher prior to the 5th of each month. Notice of discontinuance of advertising must be given before the 1st of the month, preceding issuance.

PROMINENT SHIPBUILDER'S MISCONCEPTION OF MOTORSHIPS

We are obliged to take exception to some figures regarding hypothetical motorship operation-costs recently given before the National Merchant Marine Association by Joseph W. Powell, ex-Vice-President of the Bethlehem Shipbuilding Corporation, because they are quite inaccurate and misleading and calculated to hamper the progress of the motorship industry if allowed to be absorbed into the minds of shipowners without challenge. In giving such figures, Mr. Powell is inadvertently "killing the goose that lays the golden eggs for the shipbuilder," as without a wholesale change to economical oil-engine power the American merchant-fleet undoubtedly will dwindle almost back to its pre-war days, as is already indicated on every side, and American shipbuilding then will be in an equally unfortunate position.

Referring to the economies gained by the use of the Diesel engine, Mr. Powell said "the principal saving was in fuel, and that with a 10,000 tons ship the saving would be about $100 per day, or approximately $25,000 for a 250 days' operating period, and that added to this was a small advantage due to increased deadweight of the vessel because of the smaller amount of fuel to be carried . . ." It would be interesting to know how and whence Mr. Powell obtained his fuel-saving figures, because they are far from accurate. As shown by figures issued by the Anglo-American Oil Company (see page 211, March issue of MOTORSHIP), the fuel-consumption of their 10,050 tons deadweight tanker compared with an oil-fired steam-tanker of theirs, the saving in fuel on a single round transatlantic voyage was $43,419. As we believe six to eight voyages are made in a year, the saving (if fuel prices did not fluctuate) would be from $260,514 to $347,343 per annum. This is a vast difference to Mr. Powell's $25,000 per annum.

Supposing we assume this to be an exceptional case, as it deals with tankers, why is it many dry-cargo motorships regularly show similar gains in service? For instance, Consul-General Axel Johnson states in this issue of MOTORSHIP that his Diesel-vessels show savings in their fuel-bills of $300,000 per annum per vessel compared with his own steamers on round-the-world voyages. Figures concerning the actual fuel-consumption of his new 9,600 tones d.w.c. Diesel motorship "Buenos Aires" are given in the same issue, and to the figures in question we respectfully draw Mr. Powell's attention. This vessel hasn't a cent in fuel costs! Then again there is the fuel-consumption record of the m.s. "Stureholm" in our March issue, showing that this 7,800 tons d.w.c. Diesel vessel covered 27,525 nautical-miles on 1,142 tons of fuel, carrying 42,114 tons of net-cargo in addition to bunker-oil. Assuming the average high price of $5.00 per barrel ($35.00 per ton) that has been paid in the past, the total fuel-bill for these seven voyages only amounted to $39,931—part of which she regained by selling surplus bunker-oil at higher prices. At to-day's price of $20.00 per ton, her total fuel-bill would only have been $22,840, without making deductions. We can quote a hundred such cases.

Mr. Powell says that "with the Diesel-engine the cost of fuel can be cut in half compared with a good steam-turbine installation." We won't split hairs, or we would ask why take a "good" steam-turbine job instead of an average ship? Nevertheless, we do request him to produce authentic consumption-figures of any ocean-going four-cycle Diesel-engined motorship of 1,000 i.h.p. per shaft or over in service, with which the average fuel-consumption over six months' or a year's period is in excess of 0.350 lb. per indicated h.p. hour, including all Diesel-electric auxiliaries at sea, or say 0.43 lb. per shaft h.p. hour. We also would like him to show an authentic record of the similar average consumption of say a dozen turbine-driven vessels where the fuel-consumptions at sea over similar periods has averaged under 0.95 lb. per shaft h.p. hour. Figures given us by shipowners demonstrate that the general run is 1.0 lb. or 1.1 lb. under regular conditions. Readings to be by a tortion-meter on shafting, because indicator-cards are not possible as with the Diesel-engine. We in return will produce authentic figures of not less than 25 motorships, with which the consumptions have never averaged over 0.330 lb. per i.h.p. on long voyages, and in most cases under 0.320 lb.—even with some vessels that have been in service over five years. The average fuel-consumption records of a turbine-ship after five years' operation would be interesting, particularly if no new boiler-tubes had been fitted.

Regarding Mr. Powell's reference to " . . . the small advantage due to increased deadweight because of the smaller amount of fuel to be carried," he as a shipbuilder should know that the deadweights of a motorship and of a steamship of the same dimensions are practically the same, the only difference being in the weight of machinery and boiler-water; but that the net cargo-capacity of the motorship is greater by reason of less fuel being necessary.

Mr. Powell also declared that " . . . there are increased capital charges due to the higher cost of the motorship." To compare capital charges in this manner is unfair as well as misleading. True, if you build two hulls the same size, one with Diesels and the other with steam machinery, the motorship will cost about 10 per cent more. But, for every 10,000 tons deadweight she will carry 1,000 to 1,200 tons more cargo, so why not build the motorship 10 per cent to 12 per cent smaller in size? She will still carry the same amount of net-cargo as the larger steamer, and will cost about the same! Her capital charges will then be approximately the same, while her operating charges will be at least 65 per cent less. In Europe insurance rates on modern steel Diesel-ships are lower than on steel steamers with geared turbines. These are important factors apparently overlooked by Mr. Powell.

Finally, Mr. Powell said he was a particular advocate of the oil-engine, but he wished to lay emphasis upon this fact, namely, " . . . that the belief of those who would *seize the commerce of the world* by substituting the Diesel for the steam-engine, is in his judgment a dream, and will always remain a dream." The best answer to this belief is "Lloyds' 1920 Returns of the World's Shipbuilding," which on December 31st showed 189 Diesel motorships aggregating about 727,202 tons deadweight actually under construction, without counting about 40 Diesel-vessels building in Germany. Readers should compare these figures with the returns for 1919 and form their own conclusion.

SHIPPING BOARD TO CONVERT SEVENTY STEAMSHIPS TO DIESEL POWER

Just as we had closed for press information came to hand that the U. S. Shipping Board intend to convert 70 of the A-type vessels built at Hog Island to Diesel and Diesel-Electric propelling power. These steel freighters are of 7,500 tons d.w.c. and were originally equipped with water-tube boilers and geared-turbines. At present most of them are laid-up because of shipping depression and need for repairs. Instead of replacing the gearings which have proved unsatisfactory in many instances, it is now proposed to remove the entire steam-machinery and place the vessels in a position to compete with any in the world by substituting economical Diesel-engines or Diesel-Electric-drive.

HOLLAND-AMERICA LINE'S MOTORSHIP

Considerable furore was recently produced in marine-engineering and shipping circles by an announcement given to the New York "Journal of Commerce" by Director-General Van Doorn of the Holland-America Line that his company had determined to install Burmeister & Wain type Diesel propelling-engines in the new 32,000 tons gross transatlantic-liner "Statendam" building at Harland & Wolff's Belfast shipyard, which Mr. Van Doorn confirmed to us. While such would be the most remarkable advance ever made in marine-engineering, were it correct, we doubt that such a project will be attempted until the Swedish-American Line's 20,000 tons twin-screw 16,000 i.h.p. 18-knot motor passenger-liner has made at least one voyage across the Atlantic, and which will hardly be within two years from now,—unless some enterprising shipowning company or Government purchases the two 12,000 shaft h.p. double-acting Diesel-engines now available in Germany and installs them in some existing ocean-going liner.

However, according to Harland & Wolff, the Holland America Line has just ordered from them a big combination passenger-cargo Diesel-driven motorship which will be a duplicate of the "Glenogle," "Glenbeg," etc., of the Glen Line's fleet. This being the case, she will be of 14,000 tons deadweight 6,600 i.h.p. and of 13 to 14 knots speed. Nevertheless, it is very interesting to see that this conservative Dutch steamship company has at last taken up the construction and operation of motorships.

PRESENT POSITION OF THE DIESEL MOTORSHIP INDUSTRY

Recently we inferred that the American Diesel-engine and motorship industry is in a flourishing condition. We were, of course, referring to the large amount of new development work and the increased general interest. Since then Lloyds report for the year ending December 31 1920, has been published, and an extract was given in our last issue which shows that the motorship industry of the entire maritime world is in a position never previously attained.

On that date no fewer than about 219 motorships aggregating over 1,027,000 tons d.w.c. were actually under construction in the shipyards of leading countries, or an average of 4,689 tons d.w.c. per vessel. Of these 189 of 454,502 gross tons (727,202 tons deadweight) had actually commenced construction under the survey of Lloyds inspectors, which does not include about 40 Diesel motorships of over 300,000 tons building in Germany, and which do not come under the jurisdiction of Lloyds, but which

are enumerated from reports sent in by our own correspondents. Nor does this total include a number of vessels on order, but upon which work had not begun by the end of last year. Furthermore, since that date several additional motorships have been ordered, including the new 14,000 tons liner for the Holland-America Co. and the order to convert the "Fordonian" to Diesel-electric power. The American vessels "Astmacho III" and "Astmacho IV" both are just being equipped with twin 500 b.h.p. McIntosh & Seymour Diesel engines.

In America progress is being made and greater attention is being focused upon the Diesel-engine by sheer necessity of stringent economy. No longer can shipowners afford to overlook the great savings to be effected by the use of Diesel power. One firm, the Winton Co., report that they have never before had so many orders for Diesel-engines on hand. Others advise us that judging by the apparently serious inquiries coming in, business will shortly be very bright. Several of our leading shipbuilders have just returned from Europe deeply impressed by the turn of affairs in Great Britain and Continental Europe, where steamship construction is in a very bad condition, while more motorships are completing than ever before. In two cases following the return of these shipbuilders, activities in their hitherto semi-dormant and embryo Diesel-engine departments at once began to show signs of vigorous life.

The list on this page shows what is now doing in some of the shipyards, Although not in this list the Merchants Shipbuilding Co. is seriously considering taking up Diesel-engine construction. the Sun Shipbuilding Company is also pondering over the matter, while there is very little doubt but that the Federal Shipbuilding Co.; Todds Shipyards Corpn.; and the Moore Shipbuilding Co. will start something in this direction before long, in accordance with their advices to us. It has been reported to us that the Chickasaw Shipbuilding Co. has already started work on a Diesel-engine, while an engineering firm in the Middle West, whose name we cannot reveal at this time, has commenced their first marine set. Also the Manitowoc Shipbuilding Co. and the United Engineering Works both have acquired a Tosi Diesel license, although so far they have done nothing but complete a small engine and prepare large designs. The big engine building by Craig is for the Submarine Boat Corporation for installation in a hull they have built. Experimental marine oil-engines are being built by the W. & A. Fletcher Ship & Engine Repair Co., by the Seattle Machine Works, and by the Sperry Co. So with these firms in the list we have a total of 24 American companies whose futures are more or less involved with the marine Diesel-engine construction industry. Even then we have not included firms who have built moderately-powered Diesel-engines for merchant motorships, such as the Dow Pump & Diesel Engine Co., not to speak of the several surface-ignition oil-engine manufacturers, one of whom very recently received an order for 25 sets for large 240 b.h.p. barges for the N. Y. State Canal. There are also several domestic solid-injection oil-engine builders, one of which is supplying an engine for the new Hudson & Athens motor-ferry-boat. Also the new Poughkeepsie ferry-vessel is to be Diesel-electric driven.

THAT POWERFUL INFLUENCE!

At the present time a dozen of the Shipping Board's steamers are being converted to turbine-electric drive although the first of these converted vessels, the "Eclipse," is said to be burning about two tons per day more fuel than previously and has about half-a-knot less speed, yet nothing is being done to convert any of the Board's steamers to the more economical Diesel-electric drive or to direct Diesel propulsion. More and more of the Board's vessels are being laid-up, meanwhile foreign motorships regularly leave American ports fully laden with American products. On Feb. 4th the Division of Operation's figures showed that there were 505 vessels of 3,078,000 tons d.w.c. belonging to the Board definitely tied-up and 111 vessels of 660,000 tons awaiting assignment or fixture, and that another 100 vessels may be withdrawn from trade. Also, it is estimated that the Board will lose $25,000,000 on operations in the first six months of this year. What powerful influence is at work blocking the adoption of the Diesel engine in conjection with electric drive? Certainly this system is no less experimental than the turbine-electric propulsion.

Some Large American Diesel Engines Built or Under Construction

(Revised Table of Dimensions)

Engine	Cramp-Burmeister & Wain	Bethlehem West	Worthington	Nordberg-Carels	Mc Intosh & Seymour	Busch-Sulzer	Busch-Sulzer	Craig	Skandia-Werkspoor	Newport-News Werkspoor	New York Werkspoor
Type	Four-Cycle	Two-Cycle	Four-Cycle	Two-Cycle	Four-Cycle	Two-Cycle	Nav. Type	Four-Cycle	Four-Cycle	Four-Cycle	Four-Cycle
Brake horsepower	1,750	2,500	1,760	2,000	1,525	1,250	2,250	1,850	850	1,450	1,500
Indicated horsepower	2,250	3,500	2,400	2,800	2,000	1,850	3,400	2,240	1,150	2,000	2,000
No. of Cylinders	6	6	6	4	6	4	6	6	6	6	6
Cylinder Diameter	29⅛"	25½"	29"	28"	28"	24"	...	30"	20.472"	27"	27"
Piston Stroke	45¼"	48"	46"	48"	48"	38"	...	48"	35.433"	48"	47"
Revs. per minute	115	105	120	110	105	110	...	105	135	110	110
Piston Speed (per minute)	827'	840'	920'	880'	840'	696'	...	840'	800'	880'	862'
Brake H. P. per Cyl	291	416	291	500	254	312	375	310	141	242	250
Ind. H. P. per Cyl	375	584	400	700	335	450	570	375	191	325	333
Weight (Short tons)	303 tons	350 tons	339 tons	281 tons	361 tons	175 tons	...	275 tons	148 tons	240 tons	270 tons
Weight per B. H. P.	346 lbs.	250 lbs.	386 lbs.	315 lbs.	475 lbs.	280 lbs.	...	300 lbs.	349 lbs.	330 lbs.	360 lbs.
Mean Effec. Pressure	66.3 lbs.	64.1 lbs.	64 lbs.	61.14 lbs.	65 lbs.	...	...	68½ lbs.	72 lbs.	6.33 lbs.	72 lbs.
Length Overall	43' 6"	...	45'	44'	47'-4¼"	35'	...	41'	38' 5"	35' 8"	34'

This table substitutes the table published in our February issue, as some of the figures given were incorrect, also some figures were missing. Furthermore the four Cramp B. & W. engines building for the American-Hawaiian Steamship Co.'s ships were accidentally omitted. In the above table details of the Ingersoll-Rand engine have been omitted by request. It will be noticed that seven firms are building the four-cycle type and three firms are constructing the two-cycle system. Of the latter class is the Busch-Sulzer Naval Engine. Complete details of this motor are not permissible at this time. With one exception; namely, the 1,250 shaft h.p. Busch-Sulzer Merchantship Engine, all engines are building or in service, and this particular engine will soon be started. Six of the Busch-Sulzer 2,250 shaft h.p. naval Diesel-engines are under construction. Altogether the above list represents 30 Diesel engines aggregating 98,890 i.h.p. actually on order or under construction, and include the eight Bethlehem-West engines which order has not been officially cancelled regardless of rumors, but does not include the balance of the Shipping Board's M. & S. and S-W engines.

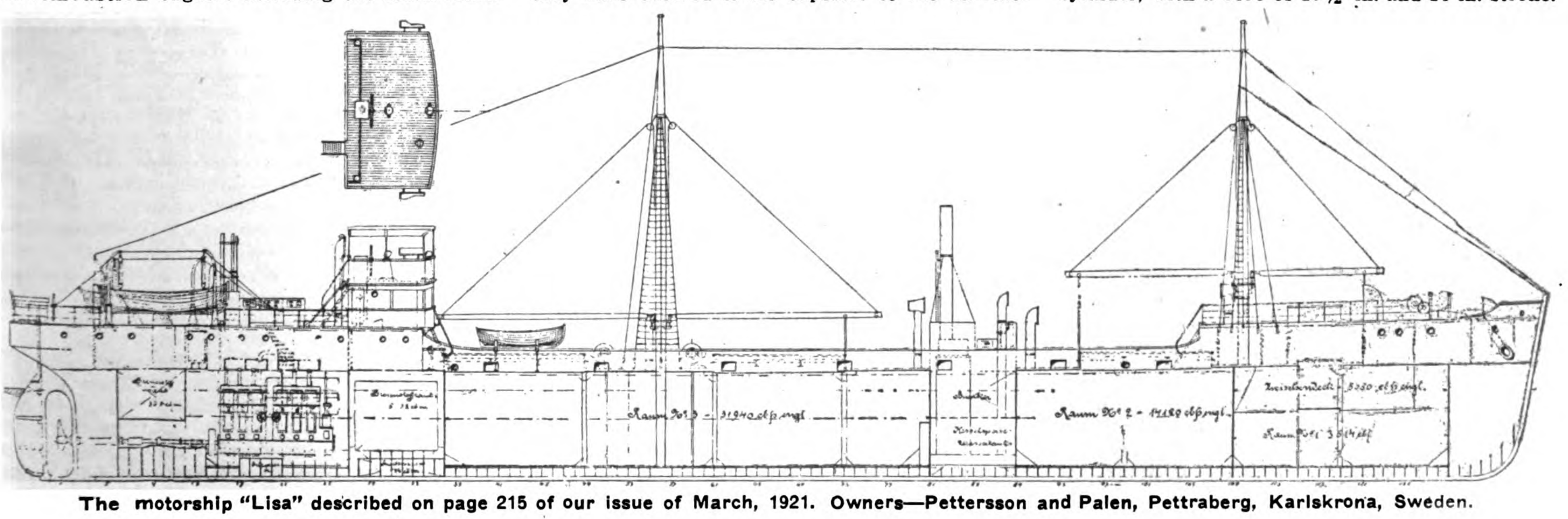
Atlas Mechanical-Injection Marine Oil-Engine

By CHAS. W. GEIGER

After making an exhaustive study as to the requirements in the field in which they now intend to devote their entire efforts, the Atlas Imperial Engine Company of Oakland, California, have decided on a definite plan to which they will adhere.

Having had a great many years' experience in both building and selling of various types of internal-combustion engines including the Atlas-Diesel motor, Mr. A. Warenskjold, President of the company stated to a "Motorship" representative that they will hereafter engage their entire plant along quantity production lines and will direct their energies to the manufacture of a solid-injection type of Diesel engine, which they lately have developed. In Mr. Warenskjold's opinion this system which they have evolved is far superior to the air-blast method of fuel-injection which was installed in the large Diesel-engines which they have built in the past—the superiority resting upon the percentage of efficiency gained.

Quantity production has necessitated standardization of all parts and they have decided that the cylinders will be made in two sizes only, namely—55-h.p. three-cylinder; 80-h.p. four-cylinder; 120-h.p. six-cylinder, all 8 in. bore with 10½ in. stroke. Then in a larger size cylinder they have—100-h.p. three-cylinder; 135-h.p. four-cylinder; 200-h.p. six-cylinder, with a bore of 10½ in. and 14 in. stroke.



The motorship "Lisa" described on page 215 of our issue of March, 1921. Owners—Pettersson and Palen, Pettraberg, Karlskrona, Sweden.

Motorships and Diesel Engines—New Construction Reports

DIESEL-ELECTRIC PROPELLED FERRY FOR POUGHKEEPSIE

It seems almost certain that the new ferry-vessel for service on the Hudson river at Poughkeepsie will be Diesel-electric propelled.

MOTORSHIPS AT BALTICA SHIPYARD

The motorships previously referred to as being under construction at the Baltica shipyard, are 350 ft. long by 50 ft. breadth and 26½ ft. depth.

"GROTIUS" A 200 H.P. MOTOR TUG

Trials have been run in Holland of the motor-tug "Grotius" owned by De Roode Ster of Rotterdam. A 200 i.h.p. Skandia surface-ignition oil-engine is installed.

WALLSEND BUILDING SULZER-DIESEL ENGINES

Sulzer-Diesel marine-engines are being built under license by the Wallsend Slipway & Engineering Co. of Wallsend-on-Tyne, England.

MOTORSHIP "SOMERSETSHIRE" LAUNCHED

At the end of February, Harland & Wolff launched the big Diesel motorship "Somersetshire," sister to their motorship "Dorsetshire" already illustrated in "Motorship."

DANISH SHIPBUILDING IN 1920

(Vessels Completed)

Motorships	25	40,000 tons d.w.c.
Steamers	16	36,700 tons d.w.c.
Sailing-Vessels	19	4,060 tons gross

Of the above motorships, three for the East Asiatic Co., totalled 26,500 tons d.w.c.

SVENDBORG S.S.CO.'S MOTORSHIP LAUNCHED

"Laisae Maersk" is the name of the single-screw motorship for the Svendborg Steamship Company, illustrated and described on page 217 of our March issue. She was launched at the Odense Staal Skibsvaerft (Odense Steel Ship Building Co.) on Feb. 12th, and will be completed about the end of May.

ANOTHER NEWCOMER

"Syren & Shipping" of London in a recent issue stated that it had been whispered to them that the present list of British motorship owners is likely to be added to before long by a well-known firm now engaged in the passenger and cargo trade. We presume they refer to the Cunard Line, as indicated in our February issue.

THE CRAIG 2,500 H.P. MARINE DIESEL-ENGINE

We recently saw the new 2,500 b.h.p. open-crankcase four-cycle type Craig Diesel-engine at the Craig plant in Jersey City, N. J. It is about 95% completed and shortly will be installed in a single-screw freighter built by the Submarine Boat Corporation. No technical details will be published until trials have been run. Many novel features of design and construction are incorporated, and the general design may be said to be strictly original and all-American.

NEW MOTORSHIP BUILDING WAYS AND DIESEL FOUNDRY

Burmeister & Wain of Copenhagen are completing their new 600-ft. building ways at their shipyard, and the first keels to be laid down will be the two motorships (Yard Nos. 310 and 317) for the Johnson North Star Line, and the motorship (Yard No. 319) for Wilhelm Wilhelmsen of Tonsberg. According to our Scandinavian correspondent, Otto Thoresen also has some B. & W. motorships on order. Motorship yard No. 318 is for the East Asiatic Company, but will not be laid-down for a short while. The new iron foundry now being created by Burmeister & Wain is making rapid progress.

SWEDISH ELECTRICALLY-WELDED MOTORSHIP

A small electrically-welded steel motorship named "Erab IV" has been completed in Sweden by the Elektriska Svetsnings Aktiebolaget at Göteborg to their own order as an experiment. The hull was welded on the Lindfors system and the total length of the welds is 5,655 feet. A surface-ignition oil-engine is fitted for propulsion purposes. There are now three welded steel motorships in service, the others being the British boat "Fullagar," and the craft built on the Kjellborg system by La Sondure Antogene Francais, of Paris, France, for service in Havre Harbor.

BIG MOTORSHIP FOR HOLLAND-AMERICA LINE

A large combination passenger cargo motorship for transatlantic trade has been ordered by the Holland-America Line from the Belfast plant of Harland & Wolff. We understand that this vessel will be practically a duplicate of the Glen Line's "Glenogle" class Diesel-driven ships; namely about 14,000 tons d.w.c., 6,600 i.h.p. and of 12½ to 13½ knots loaded speed. Recently a statement appeared in the daily-press based on a report issued by the Director-General in New York of the Holland-America Line to the effect that the 32,000 tons gross passenger-ship "Statendam". was to be Diesel-powered, which statement was confirmed to us by Director General Van Doorn himself. Evidently there has been some misunderstanding in the matter.

NEW BIG MOTORSHIP FOR LIVERPOOL, BRAZIL & RIVER PLATE STEAM NAVIGATION CO. LTD.

Among motorships recently completed in Gt. Britain is the "Leighton", a vessel of 7,300 tons gross built to the order of the Liverpool, Brazil & River Plate Steam Navigation Co. Ltd. (Lamport & Holt) by A. McMillan & Son of Dumbarton, Scotland, which is a subsidiary company. She is propelled by twin six-cylinder 26 2/5 in. by 39 2/5 in. Harland & Wolff B. & W. Type Diesel-engines. Her dimensions are as follows—

Deadweight-capacity	11,500 tons
Power	4,000 i.h.p.
Length	430 ft. 1 in.
Breadth	56 ft. 2 in.
Depth	34 ft. 9 in.

She is the first of six of these Diesel vessels on order and they have previously been referred to as building for Lamport & Holt.

ATLANTERHAVET'S NEW MOTORSHIP

Regarding the 7,000 tons d.w.c. cargo-ship building at the Southern Yard, Copenhagen, for the Dampskibsselskabet Atlanterhavet (Atlantic Shipping Company) of the same city in which a geared-turbine was to be installed, but in which a Burmeister & Wain Diesel-engine will be fitted instead. She was referred to in our February issue and her dimensions are as follows—

Deadweight-Capacity	7,000 tons
Cubic Cargo-Capacity	440,000 ft. grain
Fuel-Capacity	1,021 tons
Length (on W. L.)	375 ft.
Breadth	52 ft.
Depth to Shelter-deck	35 ft. 8 in.

There will be 10 Thrige 3½ ton electric-winches, and a special warping device astern. The steering-gear is of the electric-hydraulic type, the windlass is electrically operated, but heating is by steam from a donkey-boiler. On the boat-deck is a "wireless" cabin. Electric-light is installed throughout the ship. The keel was recently laid. The owners are now one of "Motorship's" numerous subscribers in Europe.

13,500 tons d.w. motorship "Malaya" just prior to launching. She is fitted with Burmeister & Wain's 4,500 i.h.p. Diesel-engines

SALVAGE MOTORSHIP IN SERVICE

The new 1,250 i.h.p. salvage motorship "Fritiof" was used, together with the steam tug "Harald", to tow the Eriksburg Co.'s new 14,000 tons floating-dock from Lubeck to Göteborg.

ANDORA II, A NEW ITALIAN AUXILIARY

Among Italian motor-vessels completed last year was the wooden auxiliary "Andora II," 1,056 tons gross, built and owned by Quaglia & Galdini, of Andora & Genoa. Length 201 ft., 1 in., Breadth 36 ft., 4 in., depth 20 ft., 3 in. A six-cylinder 9 4/5 in. by 10 3/5 in. Ansaldo-San Giorgio two-cycle Diesel engine is installed.

LAUNCH OF BIG MOTORSHIP "MALAYA"

Burmeister & Wain of Copenhagen have launched the new big motorship "Malaya," 13,500 tons deadweight-capacity and 4,500 i.h.p. to the order of the Diesel East Asiatic Cmpany. She is about the same as the same owners' motorship "Afrika," completed last year, and has the following dimensions:

Deadweight capacity	13,500 tons
Length (O.A.)	464 ft.
Length (B.P.)	445 ft.
Breadth	60 ft.
Depth (from A.D.)	42 ft.
Power	4,500 i.h.p.
Speed	12 knots

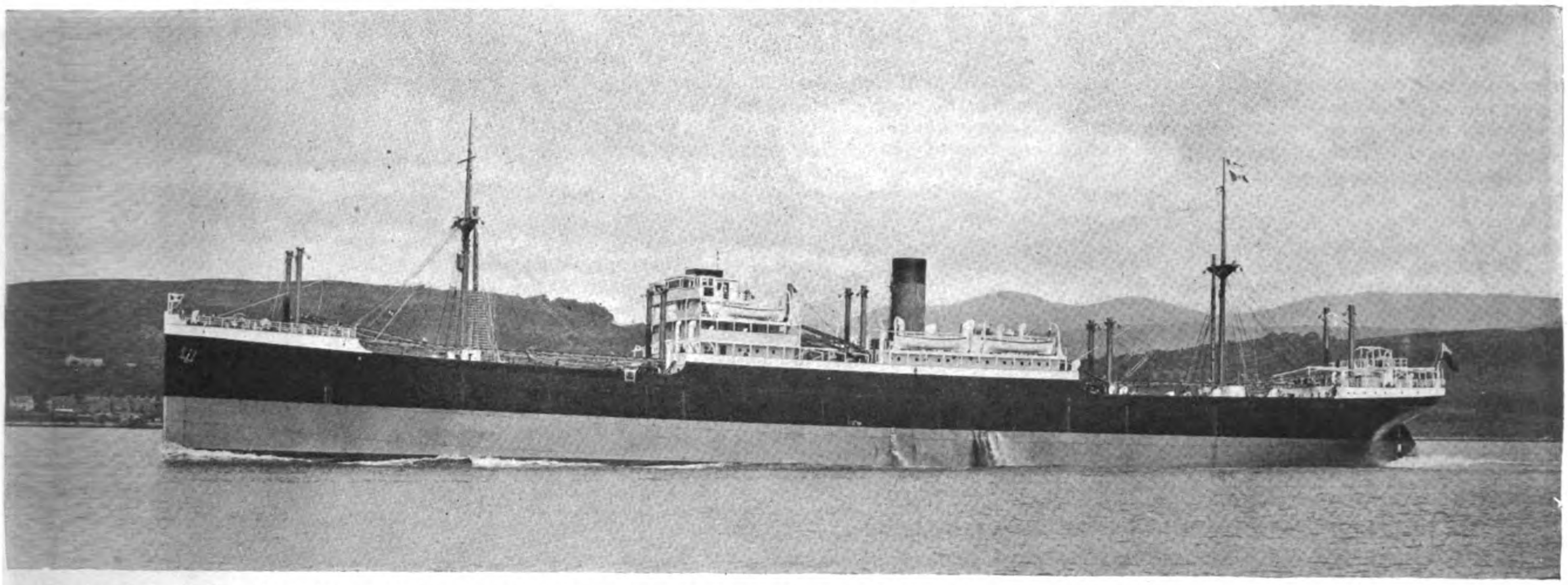
All the deck machinery is electrically-driven. A very powerful wireless is installed.

"MURIEL" A NEW 1,000 h.p. WOODEN MOTORSHIP

Among wooden oil-engined vessels recently built is the "Muriel", completed last year on the Pacific Coast at the Anderson yard, Houghton, Wash., and owned by the Scandinavian-American Bank of Seattle. Trials have just been run. She is classed at Lloyds A1, for 12 years and is of 3,200 tons bale capacity. Her propelling power consists of twin 500 b.h.p. Skandia surface-ignition oil-engines, which are said to give her a speed of 10 knots, although we estimate that an average of 9 knots loaded would be a good speed for her tonnage and power. The "Muriel" has the following dimensions—

Bale Capacity	128,000 cub. ft. (3,200 tons)
Lumber Capacity	1,600,000 ft.
Fuel-Oil Bunkers	323 tons
Daily Fuel-Consumption	4½ tons
Cruising Radius	70 days
Fresh Water Tankage	7,000 gallons and 3,750 gals. reserve
Lubricating-oil Tankage	700 gallons
Winches (steam)	Six 7 in. by 8 in.
Shaft horse-power	1,000 h.p.
Wireless	Kilbourne & Clark 1,600 miles max. range
Gross Tonnage	2,185 tons
Net Tonnage	1,597 tons
No. of Crew	23
Classification A-1-12 years	Lloyds Highest
Length overall	260 ft.
Length water line	247 ft.
Breadth moulded	46 ft.
Breadth overall	47 ft. 1 in.
Depth Moulded	26 ft.

The length of her hold is 153 ft. and she has 154 ft. of clear deck. Electric light and Markey electric steering-gear is fitted. The engines are installed aft. Her engines differ from the usual Skandia surface-ignition oil-engine in that they are of a new design with separate scavenging-pumps, instead of crankcase compression.



Harland & Wolff-built 14,000 tons d.w.c. 6,600 horse-power motorship "Glenogle." She is one of two sister Diesel-vessels in the service of the Glen Line, and two more are nearing completion. She is propelled by twin 3,300 i.h.p. B. & W. Burmeister & Wain type Diesel-engines. On her maiden voyage the "Glenogle" averaged 12½ knots for 25,000 miles, at times making 14.6 knots. Her average daily fuel-consumption is 18 tons.

Remarkable Motorship Progress on the Clyde

Review of Extraordinary Post-War Development Taking Place in Scotland in the Face of Steamship-Building Slump

By W. ROYLANDS COOPER

AMERICAN shipowners should ponder over the fact that the general slump in shipbuilding, which announced itself towards the end of last year, by the cancellation of a number of steamship contracts, and which at the time of writing is a disquieting feature in the industrial outlook, has not materially affected the position as regards the motor-vessels under construction on the Clyde.

Profiting by the experience of the Glen Line, the pioneer company of motorship owners in Britain, other ship-owning concerns have, during the past year, begun to equip their vessels with Diesel oil-engines. Chief among these are The Pacific Steam Navigation Company; The Bibby Line; Royal Mail S. S. Co.; Elder-Dempster & Co.; Lamport & Holt; the British India Steam Navigation Company, and others. A noteworthy feature observable in all cases, is that a standard type of hull has been evolved, and repeated in subsequent vessels for the same owners. This is, of course, in accordance with the practice of the Glen Line, where the "Glenogle" type (14,000 tons d.w.c. and 6,000 i.h.p.) is represented by four new ships in service, the "Glenogle," "Glenapp," "Glengarry" and "Glenbeg," and the earlier "Glenade" type (6,800 tons gross and 3,200 i.h.p.) —mostly launched in 1919—also by four ships, the "Glenade," "Glenariffe," "Glenluce' and "Glentara."

The Holland-America Line has just ordered a 14,000 tons, 13 knot motorship, similar to the "Glenogle" from Harland & Wolff, but she is being built at their Belfast plant.

Standardization of hulls and consequent economy in construction has without doubt received greater consideration following upon the adoption of highly standardized propelling machinery. That shipowners are not only being compelled by economic conditions to experiment with Diesel-propelled vessels, but that they have developed confidence in the reliability at sea of machinery, which has been thoroughly tested under all conditions of working is evidenced by the fact that British owners are now following the lead of their Continental rivals, and orders have been placed for single-screw vessels of about 6,000 tons gross, fitted with Diesel oil-engines.

Whatever may be the opinion elsewhere, there can be little doubt that in the opinion of shipbuilders and engineers on the Clyde, the motorship is the vessel of the immediate future, and shipyard and engine shops' reconstruction is all being organized to cope with this line of development.

This is particularly noticeable in the establishments owned by Harland & Wolff, who hold the British patent-rights for the Burmeister & Wain type of four-cycle engine. The extensive alterations and additions to the firm's original Diesel-engine factory at Lancefield Quay, commenced early in 1918, have now been completed, and this plant is now capable of turning out the complete engine equipment for one 10,000 tons vessel per month. [An American shipbuilder who recently visited this plant considers it the finest in the world.—*Editor.*]

This, however, is apparently inadequate for Harland & Wolff's requirements, and during the past year, the works formerly owned by the Coventry Ordnance Company at Scotstoun—an admirable site lower down the river—were acquired, and there also reconstruction work is in full progress. There is ample space for extension adjacent to the present shops, and it is expected that when completed and fully equipped this plant will rival, if not excel, that at Lancefield Quay. The craftsmanship of the Ordnance workers will doubtless prove a decided asset in manufacturing Diesel-machinery, which requires a higher grade of workmanship than is necessary in the case of merchant-ship steam-engines, whereas, there is probably no industry in which interchangeability has been so highly developed as in the manufacture of gun mountings.

On the shipbuilding side, Harland & Wolff show the same spirit of preparedness. Extensive alterations have been made at their yard in Govan; where slip-ways have been relaid, and the most modern cranes and machinery installed; but this yard is still unable to meet the demands made upon it, and the recently acquired Greenock Shipyard, formerly owned by Caird & Co., is now being vastly extended in order to provide the requisite number of hulls for the Diesel motorships on order.

Although the services of the most important foundries in the Clyde district and several further South have been enlisted, to supply the necessary castings for the large output of specialized machinery, the supply has only been maintained with difficulty. Messrs. Harland & Wolff have now decided to manufacture their own castings, and late in the summer a 40-acre site in the Govan district was secured and an extensive foundry for the production of all kinds of castings is in course of construction. This foundry will be equipped with the most up-to-date appliances for the economical production of sound marine Diesel castings.

Similiar activity has characterized the development of the North British Diesel Engine Company, at Whiteinch, Glasgow. These well-laid-out and extensive works, unique in Britain, in that they are the only works originally founded and designed to build marine Diesel-engines, are after the interruption of the war period, now fulfilling their proper functions, and the shops are fully occupied on main engines and auxiliaries for the large number of merchant-ship sets on order. Here again, the usual local foundry services have proved inadequate to supply the large number of castings required, and during the year controlling interests have been acquired in the steel works and foundries of Wm. Muirhead, of Mount Vernon, the foundry of Rennie's Steel Castings, Ltd., and the Kilmarnock firm of Grant, Ritchie & Co., these allied concerns will greatly assist the development and enhance the output of the Whiteinch plant.

A notable feature of the year has been the completion for the North British Co. of the 150-ton hammer-head crane supplied by Sir William Arrol & Co., Ltd., and the 900-ft. quay-wall which enables a ship to lie alongside the works during the fitting-out period. This crane is undoubtedly a great acquisition to the Clyde basin, and it is understood that the services of the crane will be available for other builders when not required by the North British Diesel Engine Company themselves. The first motorship to be engined by this crane, as shown in the illustration given in the March issue of "Motorship," is the British India Steam Navigation Co.'s passenger motor-liner, "Magvana," which was launched from the Whiteinch yard of Barclay Curle & Co. Ltd., on December the 24th. She has a length of 464 ft. and is designed for a speed of 13½ knots. Her two engines, which are now being fitted, each develop 2,330 i.h.p.; they are eight-cylinder, four-cycle type engines of North British Diesel Engine's own design.

It is of interest to note that several of the engineers who are to sail on the "Magvana" and sister ships, are at present in the shops and are making themselves conversant with the engines, as they are being built and tested. This is a sound and wise policy for both owner and builder, and will have as its outcome the speedy training of a capable and confident staff of engineers. It is a policy that "Motorship" for years has urged upon American shipowners.

Not very distant from Whiteinch on the opposite side of the river are the famous Linthouse yards and shops of Alexander Stephen & Sons, Ltd. Here the first two 1,600 b.h.p. engines of the Stephen-Sulzer two-cycle type are rapidly advancing, and the new work is being enthusiastically taken up. Special instructional classes are being held to familiarize the younger men with Diesel principles and practice.

At William Beardmore's Dalmuir Works considerable progress has been made with the Beardmore-Tosi engine. Chief among other or-

ders are two single-screw cargo vessels for McAndrew & Co. Ltd., of London, for the fruit-carrying trade already described in "Motorship." The principal dimensions of these vessels are 240 ft. between perpendiculars 38 ft. moulded breadth and 18 ft. moulded depth with a displacement of 3,300 tons at 17 ft. 5 in. draught. The machinery will consist of one six-cylinder Beardmore-Tosi four-cycle reversible crosshead type engine, the cylinder dimensions of which are 620 m.m. bore (24.409 in.) by 975 m.m. (38.385) in. stroke, developing about 1,100 shaft h.p. at 110 r.p.m. The speed of the vessels loaded on trial is designed for 10½ knots.

A special feature is that there will be no steam plant in the ship, all auxiliaries including winches and heaters being supplied with current at 220 volts from two Beardmore-Tosi Diesel-driven generators, each of 50 k.w. capacity. With regard to the engines, no pumps will be fitted, all being separately motor-driven. The Tosi-manoeuvring-gear is electrically operated; also Michell thrust-blocks will be fitted.

Although the name of Yarrow & Co., Ltd., has during the year been associated with one or more of the prominent firms of Diesel-engine designers, there has as yet been no definite announcement of their proposals, but they have been considering building the Werkspoor Diesel engine. Prior to the war Yarrow & Co. held an M.A.N. License and built from this design. At the outbreak of hostilities in 1914 they had on order for the Imperial Japanese Navy, two large destroyers, in which Diesel-engines driving through Fottinger hydraulic transformers, were used as cruising units. Unfortunately the international situation prevented the completion of these unique boats and the obtaining of what would have been very interesting results.

During the war several submarine Diesel engines of the Vicker's design were built at Scotstoun. At the present time, Yarrow & Co. are devoting their attention to the development of high-speed motor-craft for the navigation of shallow rivers, and as larger powers are called for they will again interest themselves in Diesel-engine work.

One of the outstanding events of the summer was the visit to the Clyde of the M.S. "Fullagar" and the successful demonstration of the Cammellaird Fullagar principle before a large and influential company of engineers and shipbuilders. As lately announced, it has now been decided that the engine originally fitted for experimental purposes is too large for the ship. This engine is to be taken out and reinstalled along with a duplicate set now under construction at Cammel Laird's Birkenhead works, in a larger vessel.

Another vessel with this design of engine is being built to the order of the Anchor-Brocklebank Line, and is now almost ready for launching at the Glen yard of Messrs. William Hamilton & Co., Port Glasgow. Her name will be the "Malia," and she has the following approximate dimensions:

Length between perpendiculars	350 ft. 0 in.
Moulded breadth	49 ft. 9 in.

The two Cammellaird Fullagar engines which will together develop about 1,300 i.h.p.—the cylinders being 14 in. bore by 20 in. stroke—will be fitted into the ship by the well-known firm of engine builders, David Rowan & Co. Ltd., who have acquired a manufacturing license for the Cammellaird-Fullagar engine, and are preparing their shops for an early commencement of Diesel-engine work.

As already announced in "Motorship," the two other Cammellaird-Fullagar licencees on the Clyde are Dunsmuir & Jackson Ltd., of Govan, and the famous Clydebank yard of John Brown & Co., Ltd. Work has already been started at Clydebank, and the castings for the first large sets of engines are now being delivered. We understand that John Brown & Co. will build the hull themselves.

William Denny & Bros., Dumbarton, have on order at present several motor-vessels which will be engined with Sulzer-Diesel engines of their own manufacture in sizes from 2,500 b.h.p. to 3,000 b.h.p., in addition to a large motorship for the Union Steamship Co. of New Zealand, which will be engined by the North British Diesel Engine Co. of Whiteinch.

Developments of considerable significance are taking place with marine engines of the Still type, which, as readers of "Motorship" are aware, embody a new principle consisting of a combination of an oil-engine and a steam-engine. The patent rights are held by the Still Engine Co., and the development of the engine for different purposes is being carried out by that Company and their Licensees. The largest engine of the type so far constructed is of slow-running merchant-service type specially designed and constructed for marine propulsion by Scotts' Shipbuilding & Engineering Co., Ltd., of Greenock.

Scotts were interested at an early stage in the development of the internal-combustion oil-engine and the first Diesel-driven submarine built by Scotts' Co., was delivered shortly before the outbreak of war. Other contracts followed and the experience gained placed the firm in a very favorable position to take part in the development of the Still engine.

An experimental Still engine constructed at Scotts' Works, is illustrated on this page the engine being erected in position for shop trials, giving some idea of the thoroughness in which the work was carried out. The engine has one-cylinder 22 in. diameter with a piston-stroke of 36 in., giving an output of about 350 brake horse-power when running at 120 to 130 revolutions per minute. This cylinder is intended to form a standard unit, so that a range of powers up to 4,200 brake horse-power can be obtained by varying the number of cylinders in line up to six per engine and employing single or twin screws. Great powers will be met by increasing the size of the cylinders.

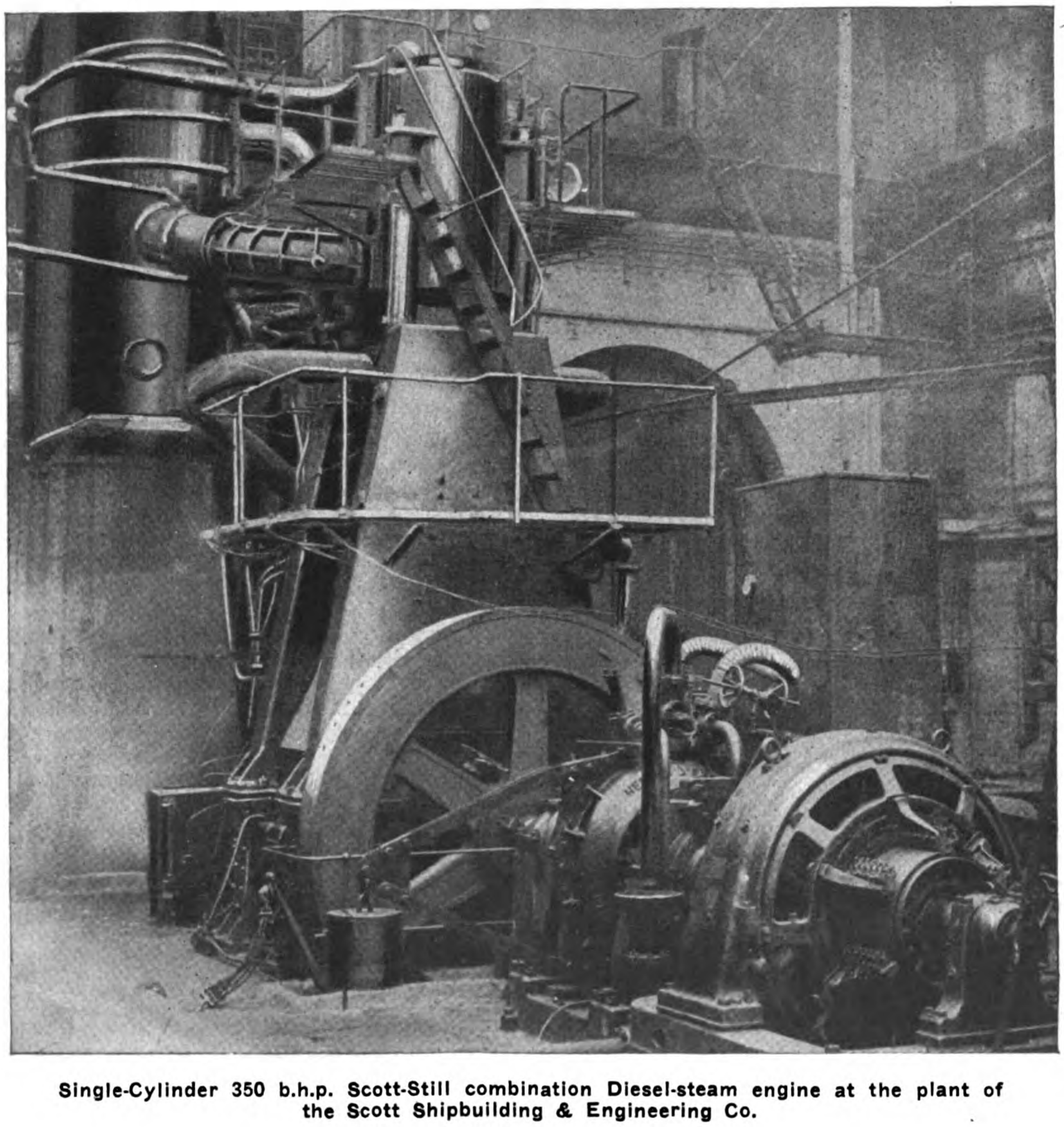
It will be remembered that the main source of power of the Still marine engine is oil consumed within the cylinder for the down-stroke, operating on the two-cycle principle, while steam forms a supplementary source of power, being used for the up-stroke on the lower side of the piston. The engine is designed to reduce heat losses to a practical minimum, the primary consideration being to accomplish this in such a manner as to improve the thermal conditions of the working-cylinders and so insure the maximum efficiency from the fuel burnt therein.

Referring to the illustration, it will be seen that a large fly wheel is fitted, this being necessary to improve the running of the singe-cylinder unit. The power of the engine is absorbed and measured by a Heenan & Froude dynamometer which also can be seen. In addition, a large electric-generator is provided which can be coupled up when necessary to absorb the power when the engine is running astern. The engine is enclosed and is provided with forced-lubrication to all its bearings, the necessary doors being provided for ready access to the crank-case when required. The method of securing the combustion cylinder by means of four through-bolts attached to the columns is indicated.

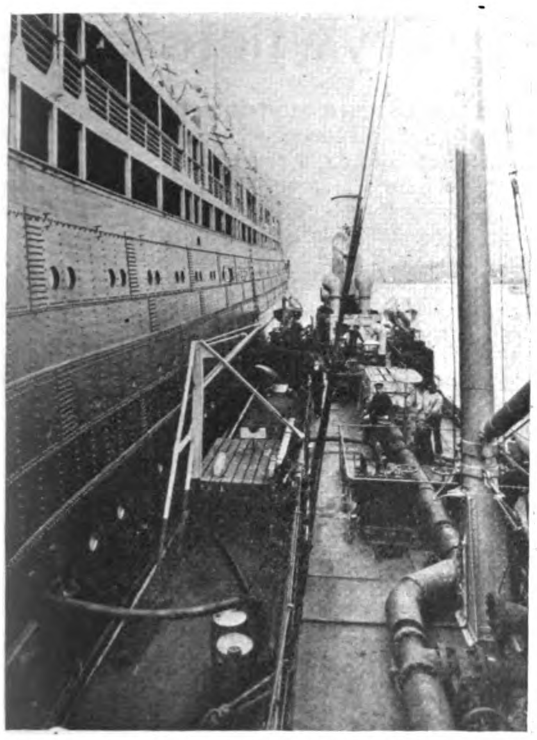
Special provision is made in the design of the structure for expansion and contraction due to heat. The boiler, which forms an integral part of the engine equipment, will be observed in the back-ground at such a height that the water level is above the top of the main cylinder-jacket. A large diameter lagged pipe conveys the exhaust-gases from the engine to the boiler, which in this instance serving the purpose of a re-generator. After passing through the boiler these gases proceed to the feed-water heater, and from this the gases pass up the funnel. Oil measuring-tanks are placed on the wall behind the boiler. There are two control-wheels, the larger wheel being employed to stop and reverse the engine, while the smaller wheel is used for speed regulation of the engine under the control of the governor.

Scavenging-air to the cylinder is supplied by a Reavell turbo-blower, which, in the experimental set, discharged to a large tank in order to minimize the fluctuation of pressure which follows the use of a single cylinder. Air passes from this tank to the bedplate, and is taken up the columns to the cylinder. The condensing plant and feed and water measuring-tanks are placed in the space beneath the boiler.

At first sight it would appear that such an engine must necessarily be relatively of a complicated nature and that it must carry the burden of oil-engine auxiliaries in addition to steam-engine auxiliaries and a boiler. Such, however, is not necessarily the case. Most oil-engined



Single-Cylinder 350 b.h.p. Scott-Still combination Diesel-steam engine at the plant of the Scott Shipbuilding & Engineering Co.



The bunkering-tanker "Scotol" fueling a ship with oil.

vessels to-day carry a boiler for steam heating, while some such vessels employ steam for port use and other auxiliary purposes. The auxiliary steam plant associated with the Still engine for starting purposes is of no larger capacity than is fitted on some oil-engined vessels. It supplies steam for starting the main-engine, oil-fuel being burnt in the furnace for this purpose in the usual manner.

In an installation of machinery on board a vessel, this steam boiler would of course be available for supplying steam to the auxiliaries in port. When the main engine is started, the oil-burner on the boiler is shut-off and the boiler then serves the purpose merely of a steam and water reservoir. The combustion-cylinder jacket and the jacket surrounding the exhaust-pipe are in circuit with this boiler. The cooling-water, therefore, enters and leaves the cylinder-jacket at a constant temperature regulated by the pressure of the steam. During combustion and expansion heat is taken up by the water circulating in the cylinder-jacket, all of which goes to form steam, and steam is also produced by heat recovered from the exhaust-gases through the medium of the re-generator or boiler (which may be designed to serve this purpose), and the feed-water heater. Steam generated from these sources when the engine is under way, performs useful work on the steam side of the main-engine piston, and may be also employed for auxiliary purposes.

During compression, owing to the cylinder-walls being at steam temperature, the air charge picks up heat, instead of losing during the greater portion of the stroke which is claimed to be an advantage of the greatest value to the Still engine. One result of this is that the compression pressure is very considerably less than in the ordinary Diesel-type engine. This enables lighter scantlings to be used, or alternatively provides a larger margin of safety, as the maximum pressure possible in the cylinder is a function of the compression-pressure. It further provides a very desirable margin for any loss of compression-pressure in service, as the pressure used in practice on the Still engine is well above the minimum pressure found necessary to ensure combustion.

In the engine illustrated, the compression- pressure is about 300 lbs. per sq. inch. The design is practically free from the array of rods, valves, and cams associated with the ordinary type of oil-engine. There are no exhaust-valves on the oil side to give trouble, and the fuel-inlet valves are automatic in action. In the experimental engine, the valves on the steam side of the cylinder are operated by oil under pressure, thus dispensing with the usual valve gear, and simplifying and facilitating the control of the engine.

Shop trials of the experimental engine have proved very satisfactory, and we are advised that the results obtained have borne-out the claims put forward. Therefore test figures would be of great interest if issued. In comparison with ordinary oil-engines it is believed that the wear and tear and upkeep expenses will be small. It has been found in practice that the manoeuvring of the Still engine is greatly facilitated by the existence of the steam side with the result that the engine is very easily handled. It is capable of relatively low speeds of revolution, quiet running and absence of vibration.

Obviously a new term will be required for a merchant ship fitted with this combination oil and steam engine, so we offer as a suggestion that hitherto has often been erroneously used, namely—"motor-steamer."

Yet another Greenock firm of engine builders have taken out a Diesel-engine license—namely, J. G. Kincaid & Co., who will build the Burmeister & Wain four-cycle type of engine under the master licence of Harland & Wolff.

Important developments have taken place during the year with regard to Clyde oil-bunkering arrangements, and the river now possesses excellent facilities for storage, distribution and rapid bunkering. Prior to the establishment of oil-tank stations on the Clydeside, oil-fuelling was effected by means of fuel delivered in railway tank wagons, either from one of the Scottish Oil Company's refineries, or from the Anglo-American Oil Company's extensive tank equipment at Grangemouth on the Forth. The Anglo-American Oil Co. Ltd. have now purchased a site near Bowling, which wil be developed later. In spite of increased competition, the excellence of these services remains unimpaired. The Admiralty storage tanks on the Forth are now connected by pipe-line to the Admiralty fuel-oil installation on the Clyde, and adjacent to this station is the Anglo-Mexican Petroleum Co.'s Installation at Old Kilpatrick, where the largest vessels may call on their way up or down the Clyde for the purpose of taking supplies of fuel-oil. The pumping plant is of the latest type, the pumps delivering approximately 300 tons of oil per hour through four 5-in. dia. hoses. The rate at which a vessel takes supplies on board, therefore, depends entirely on its own facilities for rapid bunkering. A ship fitted with one 6-in. dia. intake line is normally supplied at the rate of 100/130 tons per hour. The Anglo-Mexican Co. have at present storage for 16,000 tons of oil at this installation, the stocks being constantly replenished by tank steamer. Should supplies be required alongside vessels loading or discharging in Glasgow harbor or at ports at the mouth of the river, delivery can be arranged by lighter. As will be seen from the photograph of the "Scotol," this lighter is in itself a small installation being equipped exactly in the same manner as the bunkering-station above outlined.

Of special interest is the new installation of the British-Mexican Petroleum Company at Dunglass, below Dumbarton. A bird's-eye view of this unique station is herewith shown. On the extreme left of the picture will be seen Dunglass House and the famous "Bell Monument." This property is self-contained, and, having its own wet dock, is suitable for the accommodation of large steamers. The size of the dock is 600 ft. long by 200 ft. broad, with a depth of 27 ft. at low water. On the eastern side of the dock are three jetties, the centre one being of reinforced concrete, and the other two, timber. On the west are two fender dolphins, and at the entrance to the dock, both on the east and west side, are two fender dolphins specially constructed to allow ships to breast them for turning up stream or down. The capacity of the station at present consists of two 8,000-ton tanks for carrying oil fuel and one 3,500 ton tank for Diesel-oil. The pump room is equipped with two large oil fuel cargo-pumps supplied by G. & J. Weir, Ltd., of Cathcart, and specially designed to deal with heavy Mexican oil. These pumps are guaranteed to deliver 250 tons of fuel-oil per hour. Actual tests have shown the pumps to be capable of dealing with 50 per cent. more output. The pipe lines throughout the stations are 10 in. in diameter, and are fitted with heating devices, as previously described.

It may be mentioned that the station is provided with excellent offices and also a Customs Office to accommodate vessels coming direct to the dock. Attached to the station are three oil barges, one self-propelled of 1,200 tons d.w. capacity, and two dumb barges of 800 tons d.w. capacity. These barges deliver oil from the tail of the bank to the docks in Glasgow, and have proved very successful, having handled over 500 tons of fuel each per hour. The installation was commenced in the beginning of February last year, and will be completed by the beginning of March.

The keen interest which is being taken in Diesel matters was reflected in the very live discussion on Mr. Richardson's paper on "The Present Position of the Marine Diesel Engine" at "The Institution of Shipbuilders and Engineers.' The Scientific Society of the Royal Technical College are fortunate in having a paper by Mr. A. O. Bruce, of the North British Diesel Engine Co. of Whiteinch, on "Some Factors Limiting the Power of Diesel-engines." The Royal Technical College is also the headquarters of the research work which is being carried on by the British Marine Oil Engine Manufacturers' Association under the personal superintendence of Dr. A. L. Mellanby, Professor of Mechanical Engineering. Valuable work has been done, and is in course of progress on piston and cylinder-liner temperatures and the structure and properties of cast-iron.

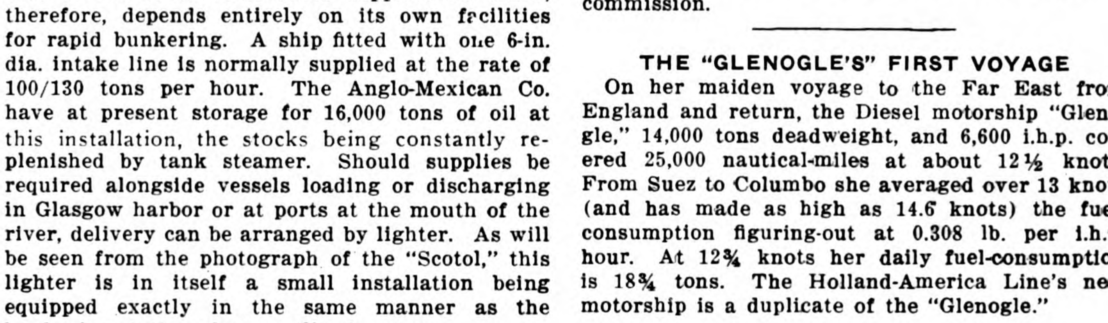
From what has been said, it is clear that the Clyde is in the forefront with regard to motorship developments, whether the problem be one of scientific research, methods of manufacture, or maintenance of efficiency of service when the ship is in commission.

THE "GLENOGLE'S" FIRST VOYAGE

On her maiden voyage to the Far East from England and return, the Diesel motorship "Glenogle," 14,000 tons deadweight, and 6,600 i.h.p. covered 25,000 nautical-miles at about 12½ knots. From Suez to Columbo she averaged over 13 knots (and has made as high as 14.6 knots) the fuel-consumption figuring-out at 0.308 lb. per i.h.p. hour. At 12¾ knots her daily fuel-consumption is 18¾ tons. The Holland-America Line's new motorship is a duplicate of the "Glenogle."

PAPERS ON DIESEL ENGINES

Two useful papers on Diesel-engine subjects were recently read before the Institute of Marine Engineers of London, and interesting discussions followed. One of these was entitled "Notes on the Management of Marine Diesel Engines" and was by Homer McCrirrick. The other was termed "The Lubrication of Diesel and Semi-Diesel Engines," and was contributed by E. G. Warne. Pressure on space prevents our dealing with the papers in this issue. Other papers recently read were "Internal Combustion Engine Auxiliaries" by W. Pollock; "Notes on the Working of Internal-Combustion Engines" by D. M. Shannon; "The Internal Combustion Engine" by Colonel D. P. Lamb, and "Hydraulic Propulsion" by Major J. H. W. Gill. But copies of these latter papers are not yet to hand. The address of the Institute is The Minories, Tower Hill, London, E. C., England.



Aeroplane view of British Mexican Petroleum Co.'s oil bunker-station at Dunglass, River-Clyde.

Interesting Notes and News from Everywhere

"MOTORSHIP'S" CABLE ADDRESS

The new cable address for the editorial and business offices of "Motorship" and other Miller Freeman publications is "Freemote New York." This covers all cable and wireless system.

MOTORSHIP "CETHANA"

We noticed that the American wooden Diesel-driven motorship "Cethana" recently put in at Balboa for repair to her donkey-boiler. Nothing needed doing to the main motors.

BUNKER-OIL PRICES IN BRITISH PORTS

At British ports steamer fuel-oil was recently quoted at £8 per ton (about $32.00), and Diesel motorship fuel-oil at £11 (about $44.00), representing a decline from the previous year of about 50 per cent.

U. S. SUBMARINES

According to a statement recently made before Congress 170 submarines have been authorized during the last four years by Congress. All but six of them are either completed or unuer construction.

AMERICAN-BUILT PATROL BOAT TO BE TUG

One of the motor patrol-boats built in America for the British navy is to be equipped with twin 40 b.h.p. Nat. surface-ignition oil-engines and operated as a tug by her present owners.

DIESEL-ENGINEER TRAINING SHIP AVAILABLE

Recently offered for sale in Great Britain among ex-German vessels was the motor-auxiliary training-ship "Grossherzog Friedrich Augusta", 1,800 gross tons. She was placed on the market by Lord Inchcape.

AFRICAN OIL NUTS CO. HAVE MOTORSHIPS

The "Meredith A. White" an auxiliary sailing-vessel of 490 tons gross has been purchased by the African Oil Nuts Co., Ltd., of London, England. Two 90 b.h.p. British Kromhout oil-engines are installed. She will trade between Liverpool and West Africa.

OIL-ENGINE FUEL RESEARCH ASSOCIATION

The British Government's Department of Scientific and Industrial Research has approved of the British Research Association for Liquid-Fuels for Oil-Engines, recently formed in conjunction with the Diesel-engine Users Association, 19 Cadogan Gardens, London, S. W.

NEW FINNISH MOTOR SCHOONER

The Reederi Nylund, of Mariahamn, Finland, are operating the new motor schooner "Signal" built by Stocks & Kolbe at Kiel, Germany. She is of 1,400 tons displacement and of 700 tons d.w.c. Her propelling plant consists of a Benz-Polar Diesel-engine of 180 b.h.p. at 250 r.p.m. built by Benz & Co., engineers, Mannheim, Germany.

AMERICAN WOODEN MOTORSHIP MAKES LONG VOYAGE

According to a letter from F. S. Nilsen, ex-Chief-Engineer of the wooden motorship "Semmeltind," and now Chief-Engineer of the sister wooden motorship "Trolltind," he recently completed a voyage almost around the world, from Portland, Oregon, to Norway, covering 19,000 nautical-miles in ninety-six days, at an average speed of 8.24 knots. Both these motorships are American built and are propelled by twin 450 H.P., Winton Diesel-engines.

TRIALS OF THE MOTORSHIP "FORMOSA"

Through the photographs of the motorship "Formosa" arriving at the same time as the report of the launch of the motorship "Canada," pictures of the former were described in our issue of February (page 136) as being the latter. Both vessels, of course, are for Mr. Dan Brostrom's companies, but the "Formosa" was built by Burmeister & Wain where the latter was constructed by their licensees, the Götaverken.

The "Formosa" ran trials on February 8th and a mean-speed of 12 knots was attained over the measured-mile, though a strong breeze was blowing and the ship in light condition. She is owned by the Swedish East Asiatic Company, and has the following dimensions:

Deadweight capacity	9,800 tons
Cubic-capacity	572,700 ft. (grain)
Cubic-capacity	519,600 ft. (bales)
Fuel-capacity	1,152 tons
Cruising-radius	29,000 tons
Speed (loaded)	11½ knots
Trial speed	12 knots
Daily fuel-consumption	10½ tons
Length (O.A.)	442 ft. 7 in.
Length (B.P.)	425 ft. 5½ in.
Breadth	55 ft.
Depth (to A.D.)	38 ft. 6 in.
Draught (loaded)	29 ft. ½ in.
Gross tonnage	7,032 tons

Her propelling machinery consists of twin 1,550 i.h.p. Burmeister & Wain four-cycle Diesel-engines of similar size to the pair in the "Buenos Aires" illustrated elsewhere in this issue, and there are also three auxilary Diesel-engines of 120 i.h.p. driving 220 volt electric generators. The fuel-consumption of the main and auxiliary machinery on the trial was 145 grams per i.h.p. hour.

The "Formosa" has two masts and one 30-ton derrick, one 15-ton derrick and ten 5-ton derricks. These are worked by eleven Asea electric winches. There is a Clark Chapman electric-winch and a Brown Bros. electric-hydraulic steering-gear. Wireless is installed. There are cabins for two passengers.

New U. S. Navy 1,000 tons surface-displacement submarine "S-48" launched by the Lake Torpedo Boat Co., Bridgeport, on Feb. 26th. She is propelled by a pair of 950 b.h.p. Busch-Sulzer Diesel-engines. Her length is 240 ft, and she carries one 4-in. gun and has five 21-in. torpedo tubes.

NEW BIG EUROPEAN OIL UNION

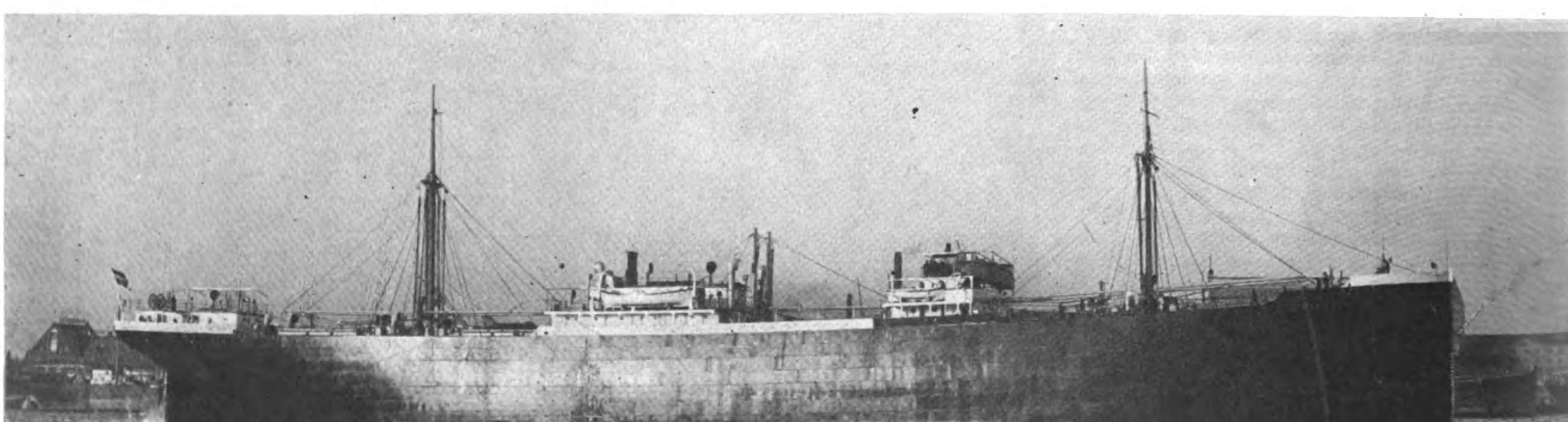
The International Petroleum Union, of Zurich, with a capital of 210,000,000 gold-francs, has been formed by Swiss, French and German capitalists for exploiting oil-wells in Alsace, Hanover, etc. One of the directors is Dr. Hans Sulzer, who also is a director of Sulzer Frérés, the Diesel-engine builders of Zurich. Swiss bankers have furnished part of the capital and will manage the Union. Of the capital F. 150,000,000 is fully paid.

MATERIALS FOR DIESEL-ENGINE CONSTRUCTION

A paper dealing with castings for Diesel engines, and the importance of using high-grade machine tools was recently read by John Holloway, before the British Association of Foreman Engineers and Draughtsmen. A resume of this interesting treatise together with illustrations is before us but we are obliged to defer its publication, owing to the mass of editorial material already on hand.

NEARLY ONE-HUNDRED PACIFIC COAST BUILT MOTORSHIPS

We take the opportunity to remind our readers that altogether over 90 auxiliary and full-powered motorships of from 2,000 to 6,500 tons d.w.c. and of from 320 b.h.p. to 2,000 b.h.p. have been built on the Pacific coast of the United States and Canada. A list of 86 of these was given on page 49 of our issue of August, 1919. Diesel and surface-ignition type of engines are fitted. These represent over a quarter-million tons deadweight, and are mostly wooden vessels.



The East Asiatic Co.'s new Burmeister & Wain Diesel motorship "Formosa" leaving Copenhagen for trial trip.

Alternative Installation for America's Cargo-Ships

Proposed Use of Surface-Ignition Oil-Engines and Electric-Drive for Auxiliary Machinery of Existing Steamers

By W. P. SPOFFORD, Chief Engineer, S. S. "Tripp"

[*The author raises many interesting points and new possibilities which could be well followed by a discussion in our correspondence columns. Many things he outlines are correct, but on the other hand some are not. For instance, we cannot agree that steam propelling machinery weighs less and occupies less space than Diesel machinery. Moreover, no space for boiler-water is required with Diesel machinery. We also suggest that the total fuel-costs given by Mr. Spofford be compared with the fuel-costs of the motorship "Stureholm" on another page.—*Editor.*]

IT is well-known that the Diesel-type of engine is the most economical prime-mover. However, for reasons best known to themselves, American shipowners are still doubting the desirability of this type of construction. Believing some changes necessary to enable American shipping to enter world competition with any chance of success, the author submits the following plan in the sincere hope and belief that it will prove beneficial to shipping and will be a move towards the conservation of fuel.

The plan involves the replacement of the customary steam-auxiliaries by direct-current electric-auxiliaries throughout, these, in turn, to receive their power from a set of three duplicate, surface-ignition, oil-engine driven electric-generators so arranged that they may be operated singly or in parallel, two of these to be capable of handling the entire machinery. These engines to exhaust into a large manifold from which it may be directed through an especially designed feed-heater, under the boilers, or into the atmosphere as desired. The feed-water from the main engines to be used as circulating-water when underway.

Direct-current electrical machinery has proven its reliability for sea purposes in the Navy, in the large passenger-ships, and in driving motorship auxiliaries. There are also some recent installations where it is being used to drive the main propellers as well. All of the late battleships have several hundred horsepower operating satisfactorily. In fact, it was found to be the only satisfactory motive-power for certain hard tasks, such as driving blowers in destroyers where a very strong draft that could be relied upon was essential.

The surface-ignition oil-engine is chosen, as of all the oil-engines it is the simplest, lightest in weight, most compact, and lowest in cost. These engines have been built for over twenty years, undergoing steady improvement. They have been operated successfully under the most trying conditions, often by wholly inexperienced men. Any of the standard companies can produce data from actual practice which will convince the most skeptical as to their reliability. Although not as economical as the Diesel, the difference in running costs at these powers would not be great enough to warrant the change with its added weight, cost and complications, except, possibly, in the very large ships. Then again, by converting the heat from the jackets and exhaust into useful work, the difference in consumption between the two types is lessened considerably.

For purposes of comparison assume a cargo-vessel 370 feet in length, by 51-foot beam and of about 6,500 deadweight tons. This vessel to have 2 single-end, 3-furnace, Scotch boilers equipped with Howdens forced-draft, Diamond soot-blowers, and superheaters capable of 100 deg. superheat at a working-pressure of 210 lbs. To have besides the usual fittings only two steam-pipes; one to the main engine, and one to a heating and fire-extinguishing manifold. The main engine to be an impulse-turbine of 1,500 S. H. P. driving the propeller through a double reduction-gear of the two-plane type† equipped with Kingsbury thrust-bearing. The turbine to be mounted on top of the condensor. The air-pump to be of the Rotrex type. An ash-ejector and a hoist to be installed in fire-room. The steering-gear to be of the electric-hydraulic type.

All auxiliaries to be electrically-driven from the generators as described. Two hot-wells to be installed one above the other, the circulating-pumps of the oil-engines taking suction from the lower and discharging into the upper when underway. The upper hot-well to be at least 10 ft. above turbine feed-pumps. The feed-heater to be of the closed type very similar to a surface-condenser. The feed-water in this case following the path of the circulating-water, and the exhaust-gases that of the exhaust steam. A scraper to be fitted on the straight tubes in such manner that it is only necessary to slide it back and forth to clean the tubes of soot. It is possible that a small induced draft-blower placed above the heater may be necessary to prevent excessive back-pressure on the oil-engines.

It would take up considerable space to set out the specifications in further detail at this time, but the above should be sufficient to give a general idea of the installation.

The turbine is selected for motive-power due to the usual well-known reasons, and because there would be absolutely no oil in the feed-water system, thus eliminating filter-boxes and grease-extractors, and preventing any possibility of oil deposits in the oil-engine cooling-space or in the boilers. The two-plane type of gear enables the turbine to be mounted over the condenser, which gives good drainage, and, when coupled with the two-plane type of gear, renders the entire high-speed element very accessible. Considering the fact that the great majority of repairs necessary in a turbo-reduction gear unit are in the high-speed element, this brings nearly all the main engine work within the scope of the ship's force and also facilitates emergency repairs at sea. The rotrex air-pump is the best adapted for motor-drive when it is not desirable to use steam for an air-ejector, as in the present case. The soot-blower is essential when coal is burned with superheaters if economy is desired.

The author has had actual experience with all the foregoing machinery, and there is no question as to its reliability given a reasonable amount of care. This vessel would burn about 25 tons of coal and 5 tons of fuel-oil a day for a speed of 10 knots. Figuring coal at $6.00 a ton and oil at $3.00 a barrel, the daily fuel-bill would amount to about $160.00. A corresponding motorship would burn for all purposes at sea about 7 tons of fuel-oil per day, or $145.00. This leaves a balance of $15.00 per day in favor of the motorship at sea, which is partly offset by the difference in lubricating-oil, the motorship using more and of better quality.

In port the fuel cost would be practically the same: The steamer would require 4 men more in the engine-crew than the motorship, amounting to $12.00 a day. Other operating expenses would be practically the same under average conditions.

It is estimated that the steam-vessel would cost $1,170,000.00 against $1,270,000.00 for the motorship, a difference of $100,000.00. Charging interest and depreciation at 10% this would impose a charge of $10,000.00 yearly against the motorship. Thus so far as straight operating costs are concerned, the steamer has slightly the better of it, but on the other hand, except for certain special cargoes, its earning capacity is not equal to the motorship. The machinery installation of the steamer would weigh less and take up less space than the motors.† However, the steamer running transatlantic would require about 1,000 tons of bunker-space for the round trip, about 700 of which is occupying space and dead-weight that could be utilized for cargo in the motorship. Then too, there is sometimes delay and trouble in bunkering which weighs heavily against the coal-burner, though lately the reverse has been the case. There is also a certain loss of speed due to cleaning fires, etc. This last, however, would be lessened greatly could our shipping-laws be altered so as to give the ship's officers some semblance of authority aboard ship.

As a motive-power for oil-tankers, vessels making long trips or running between ports where coal is scarce and expensive this installation would not be as satisfactory as the motorship. But for the usual tramp-steamer where considerable lay time may be expected, for vessels making trips up to moderate length, coastwise ships, etc., this installation would compare very favorably with the motorship. In short, it evolves itself into a question of running time, and the relative prices and facilities for coal or oil, which can best be decided in each individual case.

When compared with the ordinary steamer, whether oil-fired or coal-burning, this installation offers considerable advantages. The two types of vessels can be built at practically the same cost, and the difference in weight and space occupied by the machinery is slightly against the straight steamer for small ships, gradually increasing as the power of the auxiliaries is increased. Considerable bunker space can be saved if oil-burning, as no allowance need be made for lay time, one double-bottom full of oil being sufficient to operate the vessel nearly a year in port. The amount of coal necessary for a given trip can be figured accurately and taken at the cheapest port.

Under present conditions, with strikes, freight congestion, etc., lay time is a big factor. On the ordinary steamship one 1,000 H. P. boiler must be kept going all the time to operate often as low as 30 H. P. There is the same amount of loss by radiation as when the boiler is working full capacity, which keeps the engine-room and nearly the whole ship very hot and uncomfortable, especially in the tropics. If the valves leak, as they often do, it is very difficult to work on the dead boilers and piping. On an oil-burning vessel practically all men are on watch and boiler cleaners, etc. must be brought aboard to do the work. If a coal-burner, nearly half the men are on watch and it takes the coal-passers about half the day to get the ashes out of the fireroom, and to get out coal for the firemen. These ashes are a nuisance on the ship and in time lighters must be procured to carry them away.

Fresh water is used constantly, usually more than at sea for the oilers are not too watchful as a rule, and in some ports it is very inconvenient and expensive to get more. Then again, if the water-supply is small it is necessary to fill-up just before leaving port, often causing expense and delay if vessel is in the stream or away from supply. Every Sunday or holiday, 3 firemen, 3 oilers, and 3 water tenders get $4.80 over time, totaling $43.20, and every time ship is working-cargo or ballast at night all three must be paid. These are all small items but they aggregate quite a heavy total.

With the oil-engine and electric installation as described only one man is necessary on watch, and the power generated is in some proportion to the power expended. All boilers are dead and the ashes and coal are cleaned out of the fireroom once only. There is a large crew available to do all the work, from grinding in the main stops to cleaning and red leading the fireroom bilges. In fact, the work can be followed up promptly and deterioration largely prevented instead of having to let things go as long as possible and then bringing aboard a yard crew to renew what is gone. Overhaul bills should be easily cut in half, which under present conditions is a large item. The average engineer would rather keep a yard crew away if possible as they mess things up and often do very poor work after all.

As for steam-piping there are only about a dozen joints, glands, and valves to keep tight; hence the fresh water consumption should be very small. In winter time with the ordinary steamer great care and much coal must be used to keep the deck steam-lines and machinery from freezing, besides the great waste from condensation when in use. This is eliminated with the electric machinery. The exhaust from the oil-engines under the boilers will maintain steam while lying in open roadways or will keep the boilers dry and prevent corrosion when laid up. The fuel-consumption for this installation in port would

†The two-plane double-reduction gear referred to in this article is different from anything so far manufactured. It is designed so that any renewals or repairs may easily and quickly be made with ordinary ship's equipment and by the ship's force. This installation was primarily designed for the Cuban trade.

be from 0.2 to 0.5 ton of oil against 3 tons for the oil-fired steamers, or from 4 to 8 tons for the coal burner. At sea the saving should be about 10% for turbine and 5% or better for reciprocating vessels depending on the number of independent auxiliaries. Steam auxiliaries are notoriously uneconomical, whereas, when utilizing the jacket and exhaust heat, the oil-engines should show a very high efficiency.

A specific vessel was described to give the idea clearly and for purposes of comparison, but there are many other useful applications for this installation. This country has a large fleet of ships which are spending a good deal of their time undergoing repairs. Those that have poor main engines and boilers should unquestionably have them ripped-out and replaced with Diesels.

But, there are many which have excellent boilers and engines and yet are having a great deal of trouble due to poor auxiliaries. Many a vessel which the Shipping Board will never be able to sell as it now stands would bring an excellent price if altered as described. There are ships in which the boiler-power has been cut-down, or in which it never was sufficient for the machinery such as some refrigerating-ships built during the war. These could be improved greatly in this manner and brought up to their designed speed.

War-vessels which spend a good deal of their time in port have a great many auxiliaries, mostly electric, but steam is used as the motive power. Were this system installed on all our capital ships the yearly saving to the Government would mount well into the millions. The problem which has been worrying the designers of our new battle-cruisers, namely, getting all the machinery of the desired power below the protection deck, could be solved in this manner.

If considered desirable, motors could be incorporated on the propeller shafts giving Diesel-electric drive at cruising speeds, which would give the ships an immense cruising radius. When full speed was desired it would be only necessary to disconnect the brushes and the armatures would merely act as flywheels.

For passenger ships the lay time is small, but even so the saving to a line like the Cunard might mean the difference between a good year and a loss.

During the war a large number of turbine vessels were built. In certain circles these vessels have a very poor reputation, and even considered failures by some. In the great majority of cases this is due to no fault of the turbines, but rather to the poor layout of machinery, poor auxiliaries, and negligence or ignorance on the part of the operators. If this installation as described is laid out with equal inattention to detail the results will very likely be the same. But if care is taken to select good reliable machinery and to have it installed properly, its reliability will be equal to the best of steamers.

Without question the present type of steamer is very wasteful. On the other hand, it would be folly to scrap all existing machinery and replace with Diesels. This installation will serve to round out a fleet nicely, giving many years economical service with existing ships, and at the same time offering an opportunity for engineers and shipowners to become acquainted with the merits of the internal-combustion engine.

"Carolyne Frances," A Diesel-Driven Whaler

Wooden Auxiliary Sailing-Vessel with McIntosh and Seymour Oil-Engine

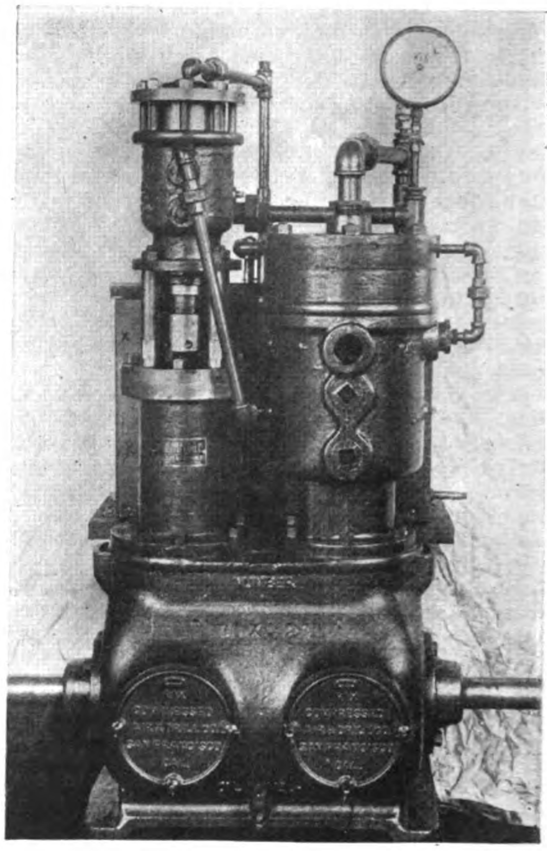
By CHAS. W. GEIGER

DIESEL engines were first used in whalers in 1912, when the "G. D. 1," and the "G. D. 2," together with their mother-ship "Sound of Jura" a large auxiliary, by a British firm. All three were propelled by Polar Diesel engines built by the Atlas Diesels Motorer of Stockholm, Sweden. There is a relation between these motor-whaler and the three-masted auxiliary whaling-schooner "Carolyne Frances" which is now on a four months whaling cruise off the West Coast of Mexico under command of Captain L. L. Lane, this permission having been granted by the Mexican Government. The "Carolyne Frances" is propelled by a McIntosh & Seymour Diesel engine, the makers of which are the American licensees of the Atlas-Polar concern.

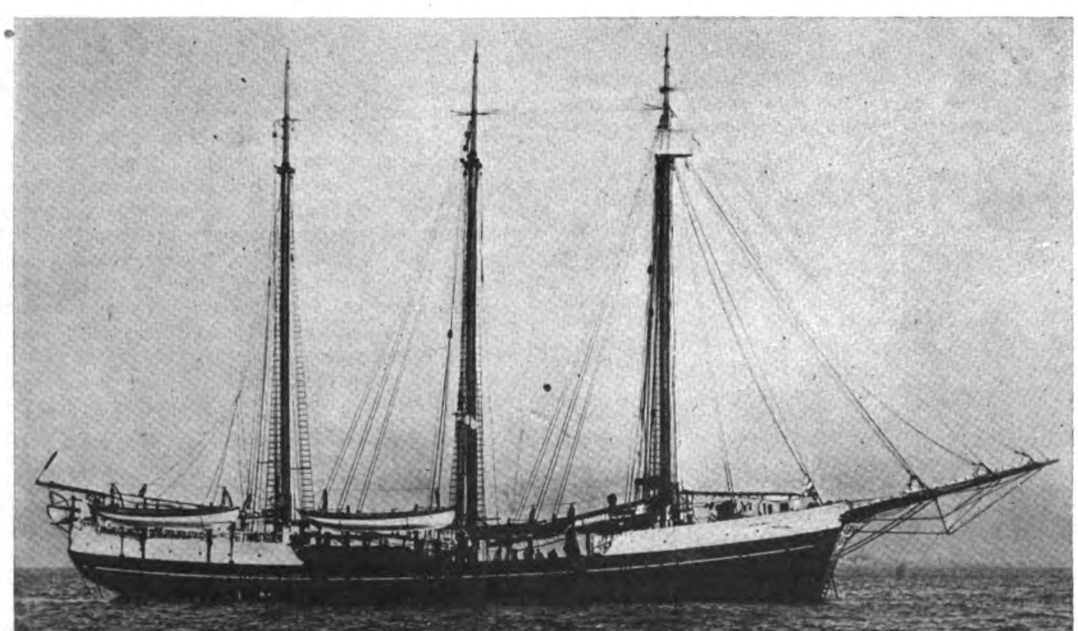
She was formerly used by the Northern Fisheries, Inc., in transporting the catch of the fishing-vessels. She was taken over by the Western Whaling & Trading Company and equipped as a whaler. A four-cycle Diesel-engine; developing 300 shaft horse-power, (390 indicated h.p.,) at 265 revolutions a minute, was installed. She carries 400 barrels of fuel, sufficient for sixty days' cruising at a speed of 6½ knots on a consumption of about 6½ barrels a day. Her length is 160 feet overall, 140 feet on the water line; with a breadth of 38 feet; and a draft of 13. Her deadweight capacity is about 1,000 tons.

She carries seven 32-foot whale-boats, built by Kneass of San Francisco. All of these boats have sails and oars, and three are equipped with 24-h.p. Wisconsin motors, with which a speed of 18 knots can be made. These boats are slung outboard from davits and supported underneath by brackets.

When the lookout on the "Carolyne Frances" discovers a whale, the fact is communicated to these boats by means of flag signals. Experiments are being made in which compressed-air is used in killing the whales. Steel bottles charged with 1,000 pounds of compressed-air are connected with a special designed harpoon by means of armored hose. When the harpoon enters the whale the air-pressure is released, which smothers the whale and at the same time keeps him afloat until he can be towed alongside the mother ship. By the use of compressed-air the struggles of the whale are reduced almost instantly, it killing him in a few minutes. One of the types of harpoon is about four feet in length. At one end there is attached a cable to take up the strain. About a foot from this is attached the air hose. At the other end of the harpoon there is a cutting device, which enables the harpoon to easily pass into the whale. Just back of this is a device which closes against the harpoon when it is pasing into the whales' body, but opens when an attempt is made to pull the harpoon out, thus preventing the harpoon from being withdrawn. The harpoon is hollow, the air passing through and out of the end of harpoon at the sharp point. There are two other types of harpoons used.



Rix air-compressor used in connection with special harpoon on motor whaler "Carolyne Frances"



The Diesel auxiliary whaler "Carolyne Frances," fitted with a McIntosh & Seymour Diesel engine

Air for the steel-bottles is provided by the regular air-compressor which is a part of the Diesel engine equipment, there being a superfluity of high-pressure injection-air for this purpose. For use in emergency a auxiliary Rix air-compressor has been installed which perform a double duty, by providing air at 350 lbs. and also at 1,000 lbs. pressure. By means of special arrangement and by a system of by-passes, one side of this compressor can be used to raise air to the injection-pressure of 1,000 lbs. The compressor is operated by a 10-h.p. General Electric motor direct connected. The compressor cylinders are 4½ in. by 1 in. and ⅝ in. by 4½ in. The air-hose is fed along to the harpoon in loops, there being special floats to keep the hose straight.

At the point of the arrow in photo No. 1 can be seen a specially designed platform on which the whale is placed to be cut up.

MESSRS. BEATTIE, QUINN & ADAMS PLEASE NOTE

We are holding copies of "Motorship" for Mr. Geo. M. Beattie, copies for Mr. G. E. Quinn and copies for Mr. J. J. Adams. These are copies resulting from paid subscriptions, held at this office on their behalf. Will they kindly call for them or send forwarding address?

Vessel With Remarkable Under-Deck Cubic Capacity

Werkspoor-Engined 6,500 Tons d.w.c. Motorship "San Paulo" Runs Trials—Has nearly 400,000 cubic-feet Capacity Underdeck

By S. SNUYFF, Netherlands Correspondent of "Motorship"

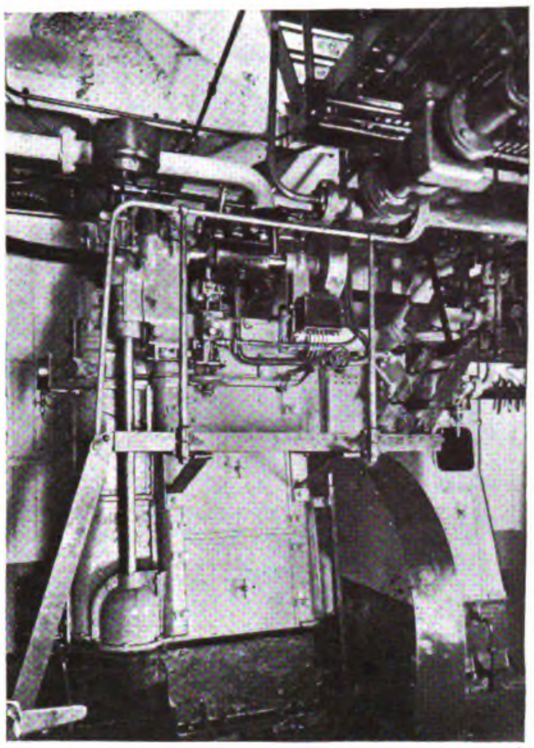
COMPLETION of motorships ordered in Holland during the war is now making rapid progress. In the issue for January of "Motorship" the trials of the "Tosca" were mentioned, and now again we have occasion to record the trials of a Dutch-built sea-going motor-vessel of importance. We refer to the "San Paulo," owned by Dampskibsaktieselskabet Otto Thoresen's Linie (Otto Thoresen Steamship Line) of Christiania and built on the yard of Naamlooze Vennootschap Werf Rijkee & Co. (Rijkee & Co., Ship-Yard Company) of Rotterdam.

This vessel is the sixth ship to be equipped with 2,200 shaft h.p. twin-screw sets developed by the Werkspoor Works of Amsterdam, and the seventeenth Dutch-built Werkspoor-engined motor freighter of more than 1,000 b.h.p. propulsive power to be placed in service. She is the third motor freighter built on the Rijkee Yards, the foregoing having been the "Meijer," owned by the Koninklijke Paketvaartmaatschappij (Royal Packet Mail Company) of Amsterdam for the service in the Dutch East Indies and the "Athene" of Dampskibsaktieselskabet Ada ved. K. Salvesen (Steam Ship Company Ada late K. Salvesen) of Kragerö, Norway. The Otto Thoresen's line has ordered seven Werkspoor-engined motor-vessels, three of which having been now completed, namely, the "Salerno," "San Miguel," "San Paulo." We were able to attend the trials of the "San Paulo" by the courtesy of the builders of the engine-plant.

A remarkable feature of the "San Paulo" is her very large under-deck cubic-capacity, due to the very small machinery space and by reason of the absence of bunkers or deep-tank other than the double-bottoms and peaks, which latter hold a total of 1,029½ tons of fuel-oil, or part oil and part ballast-water. Although of only 6,500 tons d.w.c., this vessel has a total cubic-capacity of 394,326 cubic-feet under-deck, as will be seen by referring to the drawings. This is represented by hold, 'tween-deck, and upper 'tween-deck capacities of 354,326 cubic-feet of grain, and a refrigerating-hold of 40,000 cubic-feet capacity. For the small overall dimensions of the hull, this certainly is an unusually large capacity.

Her dimensions are as follows:

Length (B.P.)	375 ft.
Breadth (M.D.)	51 ft., 3 in.
Depth (M.D. to main deck)	25 ft., 6 in. to 26 ft.
Deadweight Capacity at 23 ft., 1 in. mean draught	6,500 tons
Cubic-Capacity (total)	394,326 cu. ft.
Fuel-Capacity	1,029½ tons
Engine Power	2,560 to 2,800 i.h.p.
Cylinder-bore	560 mm (22.074 ins.)
Piston-Stroke	1000 mm (39.370 ins.)
Engine Speed	125 revs. per minute
Ship's Speed	11.5 knots
Daily Fuel-Consumption	8½ to 9 tons



Werkspoor 50 b.h.p. Diesel engine direct-coupled to a refrigerator compressor in the "San Paulo"

The ship is designed as a cargo carrier, but has accommodation for twelve passengers in six cabins, a saloon, smoking-room and bathroom. She has a straight stem and cruiser stern (as is the case with the "Athene") and the boat equipment consists of two life-boats and two "jolly-boats" with davits on the C. J. J. L. De Vos system. A wireless installation of the Horeth system is provided. The saloon is fitted in polished mahogany with mahogany framing and teak pilasters. The smoking-room is also fitted in mahogany and the rooms are provided with steam, stove and electric heating.

The main-engines are of the same design as those of the "Tosca," described in the issue of January 1921, of "Motorship." This set of engines is the second to be provided with *the new control-box* carrying a single wheel for subsequently admitting starting-air and fuel to three and six cylinders.

The auxiliary equipment, driven by the main engines, consists of:

1st: Air-compressor, driven by rocking levers off the crosshead of one of the cylinders; three-stage type with intermediate air-cooling. Each cylinder is separately driven and has its own piston-rod and crosshead guide.

2nd: Two high-pressure fuel-pumps driven off the spur-geared shaft from the cam-shaft drive. One pump can serve six cylinders, the other being provided as a spare one.

3rd: Water-cooling and cooling-water pump.

4th: Two bilge-pumps, driven off the same yoke as the air-compressor, one of these pumps may serve as a piston-cooling water pump.

5th: One low-pressure fuel-pump, driven off the extended balance-lever shaft of air-compressor.

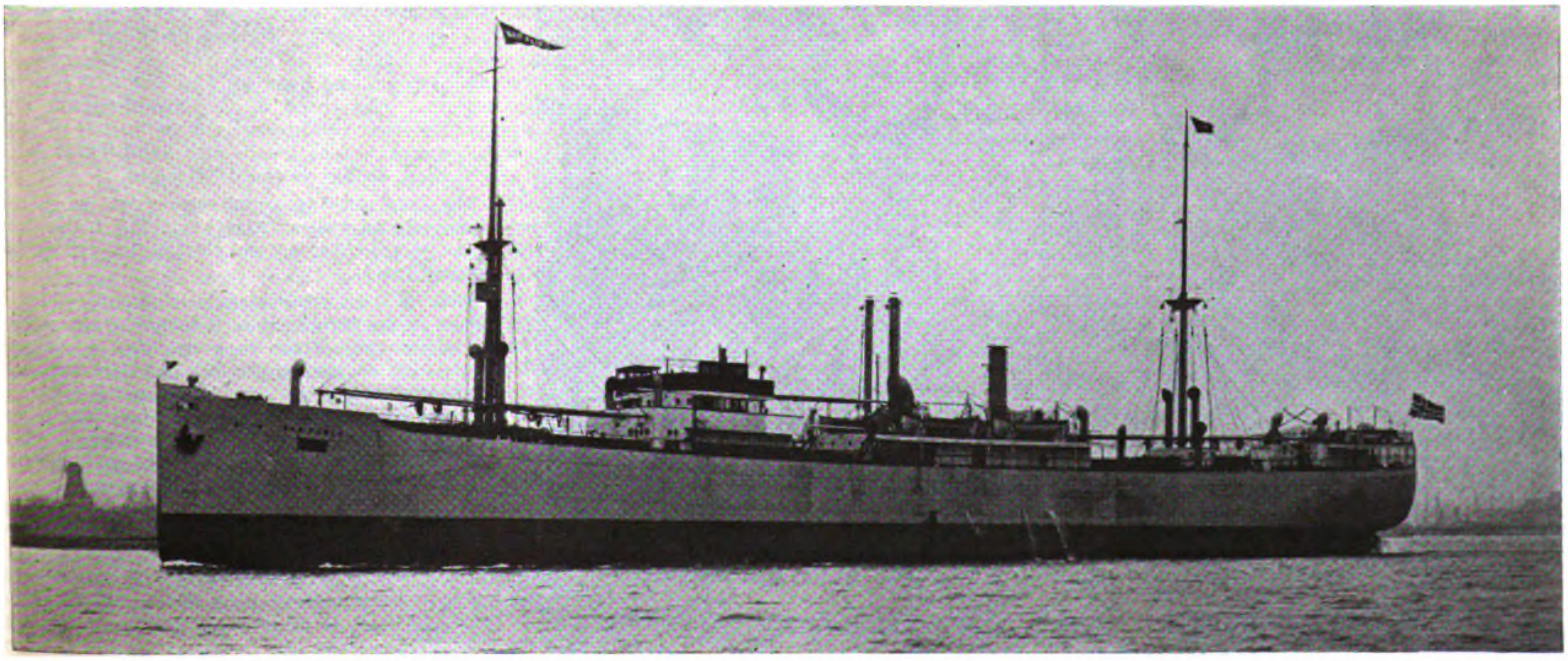
6th: One lubricating-oil pump, driven off the extended balance-lever shaft and pumping the oil out of the bed-plate into a large duplex oil-tank placed on a high level and containing a filtering plant of large capacity. The oil is cooled when passing to the tank and flows by gravity from the tank to the engine, being shut off automatically when the engine is stopped. For piston-lubrication, there are a number of small plunger-pumps driven off the cam-shaft.

Besides these auxiliaries the engines have the well-known floating fuel-oil vessel, air-vessels, fuel-oil tank and fuel-oil filtering system. The outlet of each cylinder is provided with a thermometer, for measuring the temperature of the exhaust-gases.

The thrust-shaft has a diameter of 290 mm (11.41 ins.) and is of the multi-collar system as till now has been the practice with all Holland-built Werkspoor sets. The propellers are cast-steel with a diameter of 3,600 mm (11 ft., 9.75 ins.) with four blades.

Though the independent engine-room auxiliary equipment is rather extensive we had not the impression of a crowded engine-room, regardless of the comparative short length. On the contrary, there was plenty walking-room everywhere. The length of the engine-room is not more than 50 ft., but the arrangement of the auxiliaries and their design seem to have resulted in a gain as regards space proportions.

The electric generating-plant consists of three 2-cylinder four-cycle Werkspoor-Diesel engines with the following main figures:



The new Werkspoor-engined motorship "San Paulo"

Speed ....250 revs. per minute
Power output ....80 to 100 b.h.p.
Electric output ....265 KW
Current ....220 Volt × 295 Amps direct

We may say, that the generating-engines attracted our special attention. When getting on board we were immediately struck by the remarkably steady running of the engine that was then at work with small load. There was not the least oscillation in the revolution speed noticeable, nor when listening to the sound of the exhaust. When we examined the engine in the engine-room we observed that the speed regulator had no "retarding-cylinder." The load was then about 80 to 100 amps, being about 27-34 per cent. We did not notice the least oscillative movement, as often occurs at light loads, on account of the governor movement exceeding the amount just required for close regulating, thus causing the engine to slow down.

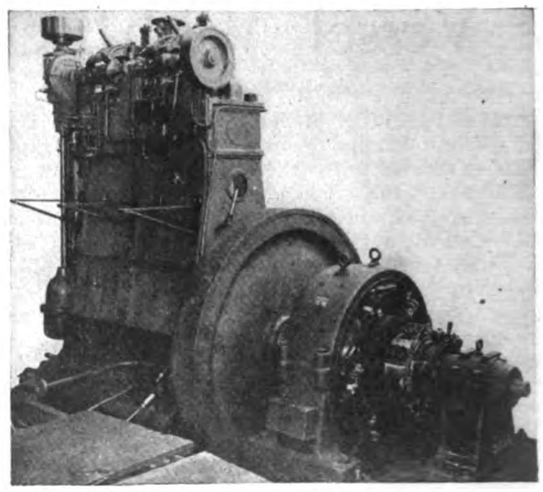
Here we may have the proof that a "retarding-cylinder" is not always necessary for preventing the oscillation phenomenon and even may have a detrimental effect, as it has a tendency to prevent the regulator from reacting directly upon the speed variations of the engine. On the other hand we have frequently experienced oscillations with engines that were not provided with a retarding device. We are inclined to think that the peculiar properties of the two-cylinder engine in connection with the type of governor, and the system of fuel regulation, play an important part. In each case we are glad to state that the two-cylinder engine functioned properly, because we believe that the two-cylinder engine is cheaper than a three- or four-cylinder model for a given power exert an unbalanced kinetic force in a horizontal sense that may have a bad effect when the speed exceeds a certain amount.

With the speed chosen—250 revs. per min.—this effect was, however, not present to any serious extent and as higher speeds are to be avoided in general with commercial Diesel-engine practice the question of kinetic balancing is not likely to prevent the introduction of the two-cylinder engine for electric-power generating on board ship.

This is of importance not only in connection with auxiliary power generating, but also with a view on the development of Diesel-electric propulsion in small vessels. If a high speed two-cylinder engine does its work well for lighting purposes it will certainly not fail to render good services when employed for propulsion-power generating as then it will have the advantages of simplicity, economy, cheapness, small weight and small space required when compared with multi-cylinder engines of same speed.

No doubt the shipping world will find interest in this engine and we may hope that we will find the Werkspoor Company inclined to provide us with more particulars about these engines, especially as regards running experiments. A detailed record of experiment results of the kind that was liberally furnished to "Motorship' by the North British Diesel Engine Co. of Glasgow and published in the issue of September, 1920 (page 810), would be regarded as a useful contribution to the knowledge and appreciation of the small Diesel-engine for ship's auxiliary drive.

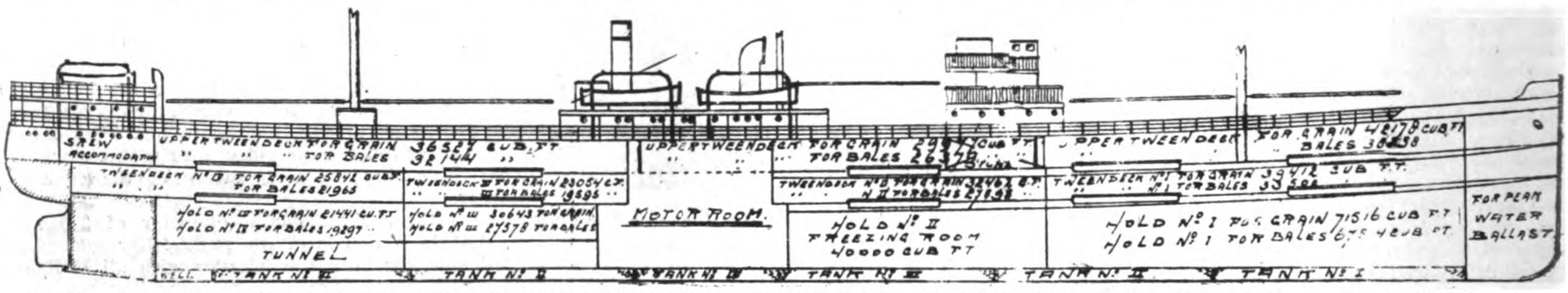
The generators to which the Werkspoor engines are coupled, are made by the Electro-technische Insdustrie vooheen Willem Smit (Electric Engineering Works of the late William Smit) of Slikkerveer, Holland. The electric generating-plant is completed by an emergency generating set, consisting of a Kromhout surface-ignition oil-motor of 7½ b.h.p. direct coupled to a 4½ k.w. dynamo, turning 550 revs. per minute.



The new Werkspoor ship's Diesel-electric generating set

The switch-board has the same position as on the "Tosca" and is perfectly accessible at the back. Current is utilized for the usual ship's purposes, provision is made for taking current from the shore, enabling the generating plant to be set at rest when the ship is in port. For this purpose a water-proof electric plug-contact is provided, mounted on the upper part of the engine-room casing. A motor-generator of Swedish make, converting three-phase current of 220-Volts into direct-current of 220-Volts having a motor of 11 h.p. is placed in the engine room in connection with the shore-contact circuit.

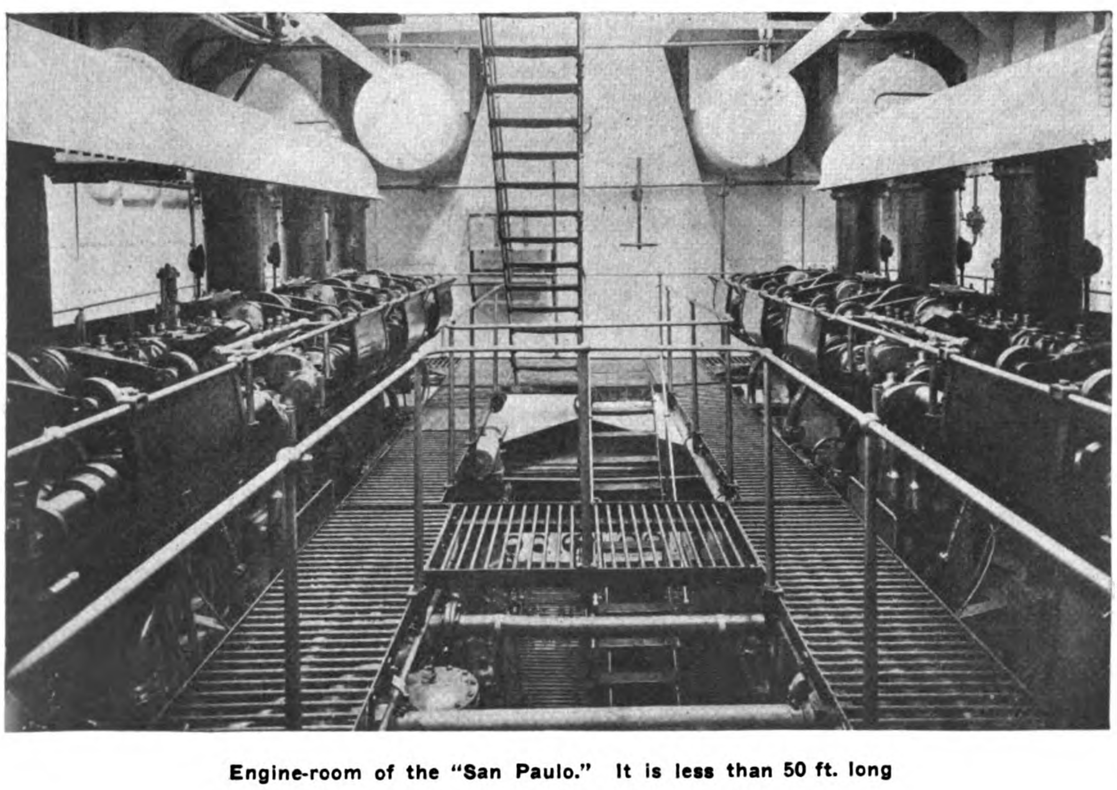
The Diesel-driven generators are located on the port side of the engine-room. On the starboard side at the after end there is a workshop, containing a shaping-machine, boring-machine and a lathe, all electrically driven by a common electric-motor by means of belt transmission, from which the power for a De Laval oil-separator, placed on the second floor, is also derived.



Profile plan of the motorship "San Paulo." Note the very small engine-room space. Her total under-deck cubic capacity is almost 400,000 cubic ft., although but 375 ft. x 51¼ ft. x 25½ ft. over all

and speed, besides having less weight and a better fuel-economy.

It must be kept in view that with the two-cylinder engine both cranks are running in parallel, so that in respect of kinetic forces the engine shows the same properties as a single-cylinder engine. That is to say, with high speeds the masses of the pistons and the reciprocating portions of the connecting-rods may be fairly compensated by the balancing-sector weight-masses on the opposite side of the cranks, but the last named masses will



Engine-room of the "San Paulo." It is less than 50 ft. long

The next auxiliary is the spare electric-driven air-compressor with a capacity of 230 cu. ft. of free-air per minute, delivered at a pressure of 65 atm. (925 lbs. per sq. in.). The motor has a capacity of 92 k.w. and turns at 275 revs. per minute.

Next to the air compressor a refrigerating-set is installed, composed of two Linde-ammonia-compressors, one of which is direct-driven by a 40-h.p. electric motor, the other by a single-cylinder four-cycle Werkspoor-Diesel engine of 40 to 50 h.p. The speed of the electric-motor can be regulated between 190 and 270 revs. per minute. The speed of the Diesel-engine, driving the other compressor can be varied in about the same range by means of a hand-wheel on the governor, visible on the illustration.

The refrigerating compressors can be worked separately as well as together. The brine-circulation is provided by an electrically-driven centrifugal pump.

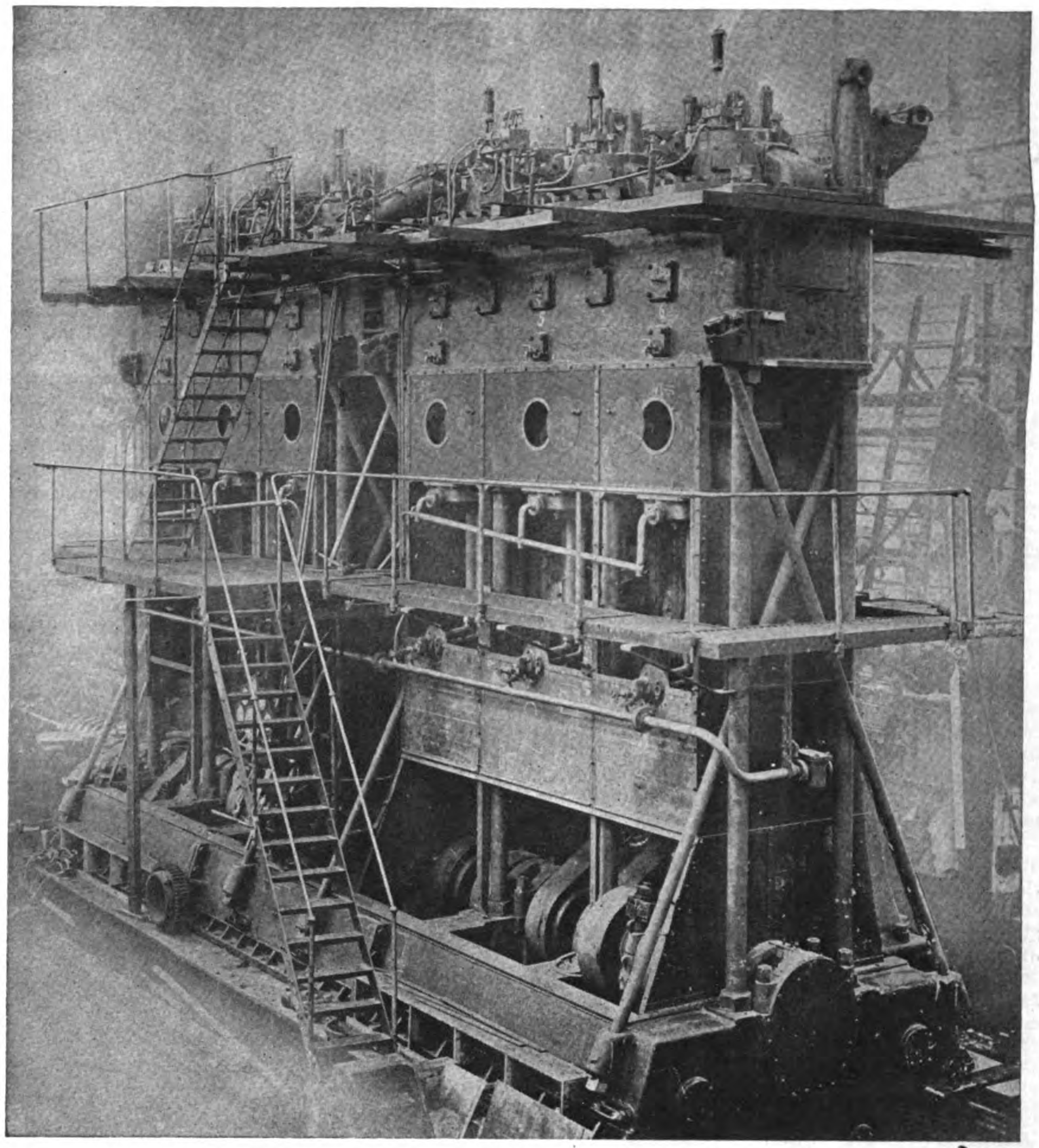
Next to the brine circulation-pump, which is placed in the fore-starboard corner of the engine-room, we find on the fore end wall a combination pump, consisting of: one auxiliary two-stage air-compressor, one double-acting piston-pump and one single-acting plunger-pump. The pumps are driven by a common electric-motor working with spur gearing. On the intermediate gear shaft the crank for the auxiliary air-compressor is mounted. When not at work the crank-end bearing of the connecting-rod of this compressor is taken off and placed on a pedestal, the crank-pin turning loose on the shaft. The double-acting pump may serve as well for bilge- as for cooling-water, sanitary- and deckwash-pumping. The single-acting one is especially for pumping lubricating-oil. The motor, driving this combination engine is of 6 h.p. and runs at 1,000

revs. per minute, and the whole engine may be regarded as an auxiliary one—used only when in port.

On the same front end at starboard two electric-driven centrifugal-pumps are placed. The one is a cooling water-pump with a capacity of 150 tons per hour, driven by an electric-motor of 16 h.p. at 975 revs. per minute. The other is a ballast pump with the same capacity, worked by an electric motor of 30 h.p. at 1,450 revs. per min. This pump can also serve for engine-cooling and deckwash purposes.

Two spare pumps (low and high pressure) are driven from the intermediate shafts of the electric-driven turning-gears for the main-engines. On the aft end of the engine-room opposite to the switch-board a donkey-boiler is installed with a heating surfare of 265 sq. ft. and a working-pressure of 100 lbs./sq. in. (7 atm.). This boiler is oil-fired and serves for heating purposes. No attempt is made to provide heating steam from the exhaust gases though this practice has already been tried by Werkspoor and, as we were informed, in some cases met with success. On this ship, however, exhaust-heat utilization is practised in connection with bath-water heating. We observed that the siren mounted on the exhaust stock was not an ordinary whistle, but a specially constructed air-blast horn.

The steering-gear is of the electro-hydraulic system with two plungers and electrically driven multi-plunger pump, which machinery is Werkspoor-made. The anchor-winch with two horizontal warping drums is equipped with a 60-h.p. electric motor, working on a worm wheel. It is made by Clarke, Chapman & Co., Ltd., Gateshead-on-Tyne, England. Of the ten electric-driven winches four are of 5-tons lift and six of 3-tons. The winches were built on the Rijkee yard and the motors for them by the Electric Engineering Works, Slikkerveer. An interesting feature with these winches is the application of so-called "breast-controllers." These are light and small controllers, hung from the shoulders of the man-in-charge and connected to the motor-resistances by means of strong, flexible cables. So the man on the controller can move from hatch to railing and vice-versa or, rather, the signalling and controller-man can be combined in one person. We think that this system may give a gain both in wage costs and cargo handling speed.



The 2,150 i.h.p. Werkspoor four-cycle Diesel engine of the new single-screw motorship "Sardinia." The "San Paulo's" engines are of similar design, but of less power.

THE TRIAL TRIP

The trial was to be held on February 17 last, at 8 o'clock. When we got on board a dense fog hung over the Rotterdam harbor, preventing us discerning anything beyond a hundred yards. However, about twelve o'clock the fog had begun to clear up and a good weather report came from the coast-guard at Maassluis. This gave an occasion to appreciate the distinct quality of a motorship to start at very short notice, or, practically speaking, with no notice at all, the vessel simply starting when the order is transmitted by the ship's telegraph!

At 12.15 the order: "Stand by" came, and when at 12.20 the telegraph indicated: "Slow ahead" the engines turned within 16 seconds in the direction wanted. Before half-an-hour had past the speed was gradually raised to 100-110 revolutions per minute, the ship proceeding to sea, which was reached at 2 o'clock.

We were much impressed by the quietness with which the engines were handled by the men-in-charge, and the moderate use of lubricating oil, resulting in a clean engine-room where it was quite agreeable to remain on watch. Indeed one would not have thought a trial trip was going on, and still less would one have believed that this was the first time that the engines were making a continuous run, if one did not know that it was the truth! From the start till the return to the starting-point there was not one moment where the engines did not perform what they were asked. Not one involuntary stop occurred during the whole 7-hours run and the exhaust was invariably clear.

We noted too the marked quietness of running of the engines and the absence of escaping gases (which in some engine-rooms cause a prickly feeling on the eyes.) Standing on the second floor however, there is some noise caused by the suction at the inlets of the air-compressors. Though this noise is not of a character to be harmful it may still be worth while to make provision for preventing it, so attaining an all-silent engine-room. [The Maxim Co., have produced a device for this purpose.—*Editor.*] The suction-inlet noise of the main cylinders has been entirely suppressed as we have already stated in the case of the "Athene" and it would be appraised by the men-in-charge if this cause of noise, though minor, were eliminated too.

Another point of some interest to the operating-men is the protection against loud reports caused by the lifting of the cylinder-relief-valves, which under some circumstances may be uncomfortable to the ear drums of the men engaged in the neighborhood of the valves; for example when taking indicator-diagrams.

In the engine-room we had pleasure to meet Mr. John Tindale, A. M. Inst. C. E. of the North Eastern Marine Engineering Co., Ltd., Wallsend-on-Tyne, who told us some interesting feats about Werkspoor-Diesel engine building in England. His firm are building the propelling engine sets for the vessels "Segovia" and "Sevilla," both being single-screw freighters building to the order of Dampskibsaktieselskabet Otto Thoresen's Linie, of Christiania. The engines will be built on Werkspoor-lines and of the same 1,000 to 1,100 shaft h.p.-type as the "San Paulo"-engines. It is of interest, that these British-built engines will be constructed in the North-Eastern works *exactly in accordance to the plans furnished by the Werkspoor Works* of Amsterdam, which is rather a departure from the practice we encountered with different foreign makers of Werkspoor-engines as the reader of "Motorship" will know from the descriptions about American- and French-built Werkspoor-Diesel engines showing the tendency of licensees to bring more or less important alterations in the general design. Which practice is the better one we may perhaps soon learn in practice by the results attained.

From Mr. Rijkee, the manager of the ship-building firm, we learned that the "Athene,"* which made her trials on July 29th, 1920, is operating very reliably and that the firm has received enthusiastic letters from her captain, Mr. I. Danielse about the performances of the ship and her engines. Certainly a great deal of the success of the ship has to be ascribed to the excellent way in which the engines are attended to by the chief-engineer, Mr. Nielsen, who is an experienced motorman.

The building of a sea-going motorship in general requires more skill from the part of the shipbuilder than is the case with a steam-ship. The requirements about strength, exactness, tightness of seams, etc., are of a more severe character. It seems an important matter to every shipbuilding yard to get experiences in this line. Mr. Rijkee assured us that the firm in every respect liked the work of building sea-going motorships and that the good results already gained were a very great satisfaction to him. Beyond the three vessels already mentioned in this article the firm has secured the order for building the "Hallrid" to the order of Kleppe's Rhederi of Bergen, Norway. The "Hallrid" will be a freighter of the same dimensions and power as the "San Paulo" and will be equipped with Werkspoor-Dieseel engines.

S. SNUYFF

Bloemendaal, February, 1921.

*According to a notice in a Dutch paper, the "Athene" has been sold to Bergenske Dampskibsselskabet, of Bergen, Norway.

Injection and Combustion of Fuel-Oil

(Continued from page 144, Feb. issue)

Experiments with Solid-Injection and Air-Blast in Marine Diesel-Engines

By Engr. Commander C. J. HAWKES, R.N. (Ret.)

Professor of Engineering, Armstrong College, Newcastle-upon-Tyne

PART II

SIMILAR experiments were then carried out with shale fuel-oil—which was the fuel used in the engine. The steel-plate was heated by a gas-burner and the temperature of the plate was measured by a thermocouple. It was found that at temperatures up to 250° F. there was no sign of the spheroidal state and each drop left a carbon deposit which ultimately burnt off, but at a comparatively slow rate. At about 250° F. the drop of oil on reaching the plate broke into a number of smaller drops and assumed the spheroidal state. The spheroidal state occurred until the plate reached a temperature of 600° F. which was the highest temperature recorded with the simple apparatus used. The subsequent evaporation of each small drop was more rapid as the temperature increased, and at the higher temperatures there was no carbon deposit on the plate when drops had vaporized.

Although the globules of shale-oil which reached the piston of the experimental engine under working conditions were much finer than the oil drops used in the experiments just referred to, the time during which the operations took place in the engine was exceedingly short. It is considered possible, therefore, that if that portion of the injected oil which reached the piston, and remained in contact with it, assumed the spheroidal state a slight delay in combustion would result. But what proportion of the fuel-oil which reached the piston remained in contact with it?

When the engine is working under ordinary conditions, *i.e.*, without the hot-plates, a certain portion of each fuel-spray strikes the piston, and it seems fair to assume that at least some of the globules striking the piston rebound—for if they did not rebound then, with the form of the combustion space of the engine, the distribution of fuel-oil would be adversely affected and the fuel consumptions recorded in this Paper would not be realized. If, therefore, in tests G and H the temperatures of the hot-plates were such that the globules of fuel-oil on striking the plates very rapidly vaporized it would follow that the distribution of fuel-oil would be modified. Under these conditions it is probable that pockets rich in fuel-vapour would be formed—in which case the rate of combustion would depend on the rapidity with which the air above the sprays mixed with the fuel-vapour in the pockets. This action would also result in delayed combustion. It is suggested, therefore, that in the engine the increased fuel-consumption and the delayed combustion with the hot-plates may have been due either to the oil-globules which reached the piston assuming the spheroidal state or to very rapid vaporization, or partly to both actions, depending on the temperature of the plates.

Rapid gasification of the oil-globules would appear to be an ideal condition so long as it is accompanied by good distribution, and had time permitted it would have been interesting to ascertain whether the hot-plates had the same effect on the fuel-consumption with air-injection as it did with solid injection.

From these experiments it seems clear that in the case of a solid-injection engine of comparatively high speed using shale fuel-oil the sprays should not strike a very hot piston. In the experimental engine the centre line of each spray strikes the piston at an angle of about 75° to the tangent to the surface at the point of striking.

It has been stated, however, that with a certain engine of comparatively low speed an improvement in consumption has been obtained by causing the fuel-sprays to pass over a heated surface, but in this instance the sprays hit the heated surface at a small angle and the fuel-oil used was a petroleum fuel-oil of heavier grade than shale oil.

Up to this time the best consumption figures had been obtained with the sprayer provided with five holes 0.016 inch in diameter, without any special hoisting devices. Comparing tests E and F, Table I., it will be seen that the fuel-consumption was slightly reduced by increasing the fuel-injection pressure. When carrying our tests at higher injection-pressures, however, it was noticed that increasing the fuel-valve roller clearance beyond a certain point did not give any better results.

It was also noticed that the fuel-valve roller did not follow the contour of the cam, and it was decided to take valve-lift diagrams from the engine when running. For this purpose an extension was fitted to the fuel-valve spindle, and an ordinary indicator was secured to the fuel-valve body so that the spindle extension pressed against the underside of the indicator piston. The drum cord was then connected to an indicator-rig which was approximately 90° out of phase with the piston. By this means the fuel-valve lift diagrams were obtained. A 200 lb. indicator spring was used.

Copies of actual diagrams, the ordinates of which give the lift of the fuel-valve magnified six times, are shown in Figs 4 to 7. The quadrant of the fuel valve cut-out lever was notched. Notch 4 represents the position in which the fuel valve had its full lift, notch 2 the lowest lift position at which tests were made and notch 3 an intermediate position.

Fig. 4 shows one of the first valve-lift diagrams taken with the sprayer provided with five holes 0.016 inch in diameter.*

5 Hole Sprayer. Holes ·016" Dia.
Revs. 380. B.H.P. 100.
Curve 1. Barring round Diagram, Notch 4.
" 4. Running Diagram, Notch 4. Fuel Pressure 3,700 lbs.
" 2. Barring round Diagram, Notch 3.
" 5. Running Diagram, Notch 3. Fuel Pressure 5,200 lbs.
" 3. Barring round Diagram, Notch 2.
" 6. Running Diagram, Notch 2. Fuel Pressure 5,600 lbs.

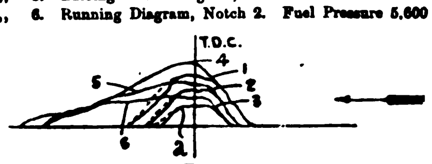


Fig. 4.

4 Hole Sprayer. Holes ·0'6" Dia.
Revs. 380. B.H.P. 10.
Curve 1 Barring round Diagram.
" 2. Running Diagram. Fuel Pressure 4,100 lbs.
" 3. " " " " 5,000 lbs.

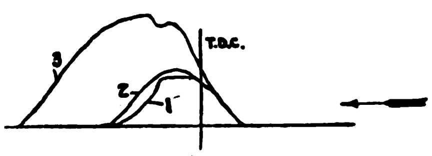


Fig. 5

5 Hole Sprayer. Holes ·019" Dia.
4th Notch of Quadrant. Fuel-Valve Roller Clearance ·003.
Revs. 380.
Curve 1. Barring round Diagram.
" 2. Running Diagram. Fuel Pressure 2,500 lbs.
" 3. " " " " 4,000 lbs.

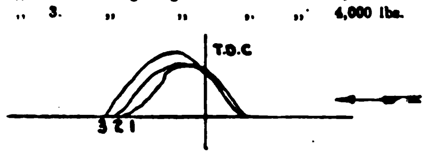


Fig. 6.

5 Hole Sprayer. Holes ·019" Dia.
2nd Notch. Roller Clearance ·090"
R.P.M. 380.
Curve 1. Barring Diagram.
" 2. Running " Spring load of 618 lbs.
" 3. " " " " 750 lb.

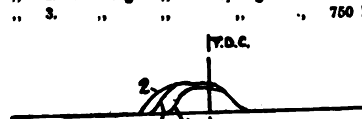


Fig. 7

The effect of "notching out" on the movement of the fuel valve is clearly indicated. Curves 1, 2 and 3 represent the movement of the fuel-valve for each position of the cut-out lever when the engine was barred round, *i.e.*, when the fuel-valve roller followed the contour of the cam. The breaks in these curves, *e.g.*, at "*a*" in curve 3, are due to the back-lash of the camshaft driving mechanism which is taken up by the load on the fuel-valve spring when the top of the cam passes below the roller. Curves 1, 2, and 3 are, therefore, not correct as drawn, but should be somewhat as shown dotted.

Valve-lift diagrams were also taken with a sprayer provided with four 0.016 inch diameter holes and these are shown in Fig. 5. With this sprayer the effect of increasing the fuel pressure is most marked—but it must, of course, be regarded as an extreme case.

Valve-lift diagrams obtained with a sprayer provided with five 0.019 inch diameter holes are shown in Fig. 6. Curve 1 is the "barring" diagram and making the necessary correction for the back-lash in the driving mechanism it will be seen from curve 2 that when the engine was running with the normal fuel pressure of 2,500 lbs. per square-inch the roller practically followed the cam. At a pressure of 4,000 lbs. per square-inch the roller began to leave the cam (curve 3, Fig. 6). In this instance a valve-spring was in use loaded to 618 lbs. when the valve was in the closed position.

The effect of increasing the spring-load was next ascertained. Fig. 7 shows the diagrams obtained with the 0.019 inch-hole sprayer. Curve 1 shows the "barring" diagram. Curve 2 is the running diagram with a spring load of 618 lbs. and a fuel pressure of 4,500 lbs. per square inch, and curve 3 is the running diagram with a spring load of 750 lbs. and a fuel pressure of 5,200 lbs. per square inch. The quantity of fuel-oil passed was the same for curves 2 and 3. The effect of the stronger spring is fairly marked but it is still insufficient to cause the roller to follow the cam.

Better results were obtained by increasing the load on the spring to 850 lbs., but, with the minimum valve-spindle friction, no appreciable advantage was obtained by increasing the spring load beyond this figure.

It was considered desirable at this stage to investigate the fuel-valve cam, spring, etc., and to ascertain under what conditions "jumping" of the fuel valve was likely to occur. The curves shown in Fig. 8 were therefore prepared. Curve "*a*" represents the curve of velocity of opening and closing of the fuel valve; curve "*b*" represents the forces necessary to accelerate and decelerate the valve, etc., curve "*c*" represents the load due to a 618 lb. spring, and curve "*d*" the spring load available after deducting the forces necessary to accelerate or decelerate the valve and its operating gear.

Table 2.—Variation of Pressure in Injection System.

Maximum pressure. lbs. per sq. inch. (*a*)	Minimum pressure. lbs. per sq. inch. (*b*)	Fluctuation of pressure. lbs. per sq. inch.	Mean of (*a*) and (*b*).
4,560	3,440	1,120	4,000
4,320	3,280	1,040	3,800
4,240	3,200	1,040	3,720
4,000	3,040	960	3,520
3,680	2,800	880	3,240
3,480	2,640	840	3,060
3,360	2,560	800	2,960
2,840	2,160	680	2,500
2,360	1,720	640	2,040
2,000	1,400	600	1,700
1,920	1,360	560	1,640

Diagrams had previously been taken from the fuel-system with the object of ascertaining the variation of pressure during the cycle. For this purpose an ordinary hydraulic-indicator was used, but as shale-oil was found to leak past the indicator-piston a U-pipe connection was made to the indicator which was filled with a viscous oil—so that the heavy-oil was in contact with the piston. This overcame the leakage difficulty, and it is considered that reliable records of the variations of pressure were obtained. Table 2 shows the maximum and minimum pressures recorded when pumping varying quantities of fuel-oil, with the engine running at 420 R.P.M.

(Fig. 8 will be given in the next installment)

*It was subsequently found that the load on the valve-spring in use was slightly less than 618 lbs.—which was the load on the standard springs fitted in submarine engines in 1914.

Reconditioning the "Bacoi"

Installation of a Pair of 640 I.H.P. McIntosh & Seymour Diesel-Engines and New Auxiliary Equipment

By R. D. KARR

SOME of those familiar with the peculiarities of tank-ships in operation and the special requirements of the service see but little advantage in using the internal-combustion engine as the main power unit where a comparatively large-sized boiler is required for heating cargo and steam smothering for fire control. But the newly equipped motor-tanker "Bacoi" recently delivered to the L. C. Gillespie Co. of New York City will demonstrate that such a dual equipment can be of very great value. This company's business involves the importation from China of quantities of oil extracted from some native woods and used in the manufacture of paints and varnishes. This Chinese wood-oil is thick and hard when cold, but becomes quite watery when heated, so that it is perhaps ideal as a cargo if proper and sufficient means for heating the same are provided. While at sea the oil will resemble the natural wood gams while cold, thus possessing a minimum of fluidity, and the free surfaces of the oil will not cause much diminution of the latent stability of the vessel.

It may be mentioned that this vessel was originally built in Great Britain for service on the Great Lakes in 1912 under the name of "Calgary." Several years ago she was converted to a tanker and owned and operated in the Baltimore district by the Standard Oil Co. of New Jersey as a distributing vessel for refined-oil, such as water-white, gasoline, etc.

Although rather large for her new service, she is at first glance seemingly small for the run between Shanghai, China, and Tacoma, Wash. It may be mentioned right here that a vessel of this size with an equivalent steam plant would require about half the boat's deadweight capacity for the coal or oil for a round trip—thus automatically placing its operation beyond the bounds of an economic possibility. As it is, however, the vessel can be operated at a cost that results in a reasonable cost per bale of cargo transported and in amounts sufficient to keep pace with the facilities in China for assembling the required amount of oil between trips to Tacoma and return.

Thus we see that in the case the Diesel oil-engine lies at the crux of the whole situation, without its enormous cruising radius on a moderate double-bottom storage capacity, the operation would immediately have attached to it elements of uncertainty and expense that would have hampered initiative and probably forbidden the enterprise all together.

The dimensions of the "Bacoi" in her new condition are as follows:

Displacement (loaded)	3,525 tons
Dead-weight capacity	2,200 tons
Net cargo-capacity (10,420 miles voyage)	1,900 tons
Fuel-capacity	500 tons
Fuel, stores, water, etc., required on round voyage (10,420 miles)	525 tons
Ratio of net-cargo to displacement (10,420 mile voyage)	53%
Length	248 ft.
Breadth	42 ft. 5 in.
Depth	19 ft. 1 in.
Draught (mean loaded)	14 ft. 3 in.
Power	1,280 i.h.p.
Speed (loaded)	10 knots
Built	1912
Reconditioned	1920-1921
Builders	Swan, Hunter & Wigham Richardson
Re-conditioners	Vulcan Iron Works
Engine-builders	McIntosh & Seymour
Gross tonnage	1,696½ tons
Net tonnage	1,185 tons

Delivered to the L. C. Gillespie Co. by the former owners in July, 1920, the vessel was towed to the yard of the Vulcan Iron Works in Jersey City, N. J., for the reconditioning and installation of twin six-cylinder, four-cycle, 500 shaft h.p. (640 i.h.p.) McIntosh & Seymour Diesel-engines and a Ward watertube boiler for auxiliaries, cargo-heating, pumping. Considerable structural work was involved in the proposed changes including cutting away the old engine-room bulkhead aft of No. 4 cargo-tank, and building a new one, or rather two bulkheads with a cofferdam between about five frames forward. This required cutting off a segment from the after side of the No. 4 cylinder tank giving a flat surface in the tank about twenty feet wide.

Ordinarily with the Jack tank system no stiffening is required, due to their cylindrical shape; but naturally the flat surface of the new bulkhead required full strength as is demanded for ordinary oil-tight bulkheads. In addition to the extensive underwater charges necessitated by relocation of the propeller-shafts, bossing of frames and shell plates, new shaft brackets, etc., a complete new poop-house was built of steel—to provide quarters for the engineer's force, to house the steam-boiler and incidentally to raise the engine-room skylight.

In profile the vessel has really quite changed, for the pilot-house, captain's and mates' quarters, with upper bridge all intact; was disconnected from its location at the aft end of the hull and moved bodily aft to a new skeleton structure erected amidships. This undoubtedly increases the general appearance of the boat and will tend toward more efficient handling at sea and in crowded waters, while also permitting better protection to the deck-force while on watch.

Below decks the bulkhead at the after end of the forecastle is continued to the tank top to separate the pump-room from the refrigerator space. In this pump-room is located a large duplex horizontal Wilson-Snyder oil-pump 14 in. by 10½ in. by 18 in.—with 12 in. suction and discharge connections. A smaller Worthington horizontal duplex pump is connected by 3-in. suction and 2½ in. discharge lines to the forward fuel-oil tanks including the forepeak. This is used as a transfer-pump to deliver oil aft where it may be fed to the high gravity service-tanks as required.

The refrigerating machinery is of the Brunswick type—the compressor being driven by a 4 in. by 4 in. steam engine. Circulation is taken care of by a small Worthington horizontal duplex—a pump which had previously done service elsewhere on the boat. To install such an outfit was obviously the only logical thing to do, as to carry ice enough to keep food a month would be impracticable as well as prohibitive in cost. Besides the lower maintenance cost, the better living conditions resulting from properly preserved foods will become a large factor in the crew's contentment and efficiency.

There are four main cylindrical Jack tanks for cargo in the "Bacoi" and the four double-bottom tanks for ballast and fuel, besides the after-peak for fresh-water, the fore-peak for fuel and a deck-tank at the forward end of the poop-deck also for fuel.

On the platform level outboard of the starboard engine is located the Egsberg 7 in. by 7 in. steam driven electric generator, 120-amperes, 110-volts at 400 r.p.m. A Westinghouse standard panel is arranged for two power circuits—one from the above generator and one for the Mietz surface-ignition engine-driven dynamo located in the lower engine-room. There are eight feeder-circuits provided for lighting and two for power to various motor-driven auxiliaries. All switches are double pole, two-throw knife-switches. The two-power feeders have overload and no voltage releases. Each generator circuit has its own volt and ampere meter.

At this level near the forward bulkhead is the steam-trap for collecting oil and water from the exhaust-steam from the cargo heating-coils. Aft of the steam-electric unit is a hot well and filter tank, and an Alberger 350 sq. ft. condenser mounted over a combined wet and dry pump. Near the hot-well are duplicate Worthington feed-pumps. Aft of the condenser near the shell is a Row and Davis distiller with a small Worthington pump for salt-water feed.

At the after end on the upper level is situated the Ward water-tube auxiliary boiler. It is equipped to burn oil under forced draft, the fuel being fed by a White fuel-oil unit. The forced draft is provided by a small Simplex turbo-blower furnished by the Power Turbo Blower Co., of New York. The boiler, tested to 300 lbs. per sq. in., is made of Lukins Steel Co's. boiler plates—6,000 lbs. per sq. in. elastic limit.

On the port side at this level there are arranged from forward-aft three lubricating-oil trunks, Excelsior hand bilge-pump—two Richardson-Phoenix lubricating-oil filters for the main engines and the engine-room machine-shop and tool-room. This machine-shop, enclosed in a wire netting is equipped very completely. The lathe is a particularly fine piece of equipment. It is a National Lathe Co.'s machine from Cincinnati, back-geared to a 3 h.p. Western Electric motor, controlled by Cutler-Hammer starting and overload controls. The whole outfit was supplied by the Wickes Machinery Co., Jersey City, N. J. In addition there is a Hoosier Drilling Machine Co.'s drill-press, made in Goshen, Ind., and furnished by Van Dyk Churchill Co. of New York.

On the lower level of the engine-room the port side is given over principally to duplicate cooling-water circulating-pumps and the main bilge and ballast-pump. The circulating water-pumps are Goulds centrifugal, 10 h.p. electric motor-driven type at 165 r.p.m.; the suction is 6 in. and discharge 4 in. diameter. The main ballast, fire and bilge pump is the original installation, being a Lamont (English made) vertical duplex 7 in. by 9 in. by 8 in. This has not been changed except to be opened up and overhauled. In addition there is a small sanitary-pump and a new Dean duplex auxiliary engine-room and forward bilge-pump.

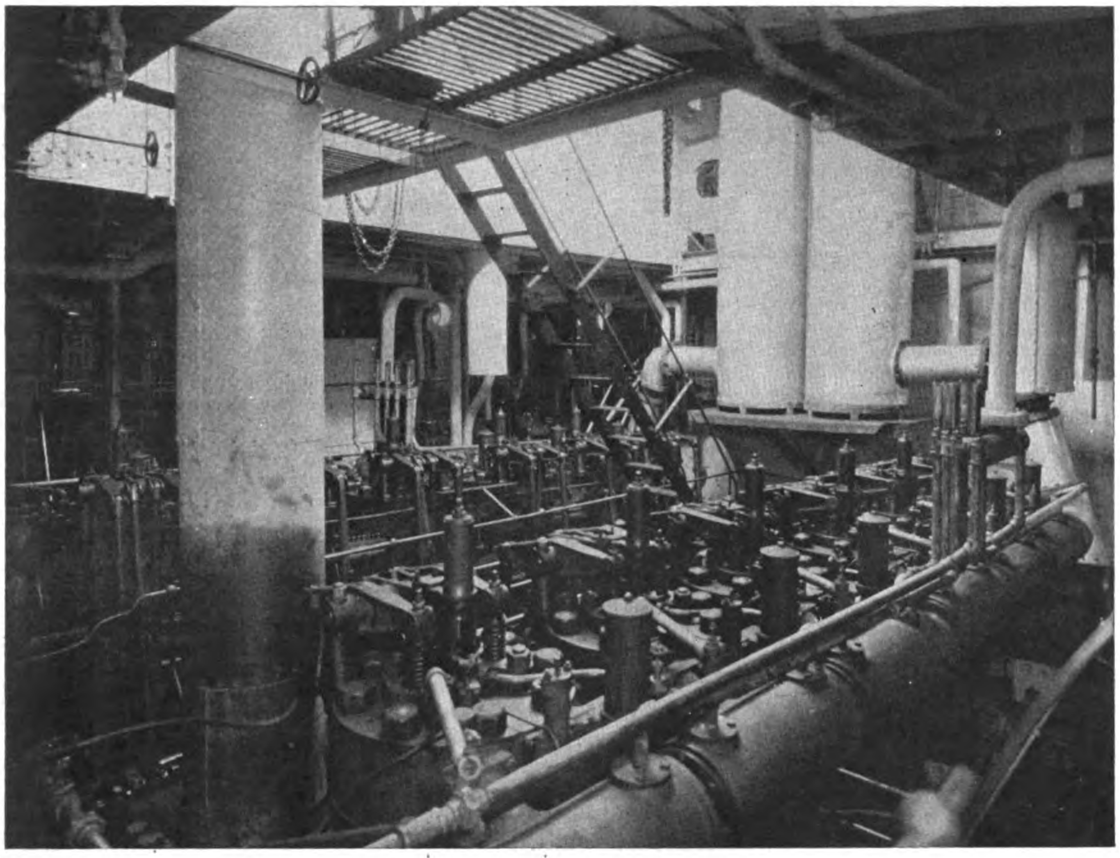
Against the forward bulkhead on this side is a vertical duplex Lamont auxiliary fuel-oil transfer pump. On the starboard side is a motor-driven Kinney gear-pump. The pump is driven through a silent chain by a Crocker Wheeler electric-motor running at 1,300 r.p.m. A Cutler-Hammer two h.p. starting-box is used.

There remains on the starboard side only the Mietz single-cylinder 15 h.p. oil-engine direct-connected to a General Electric 10 k.w. electric-generator, and a Bury air-compressor. A McCord mechanical-lubricator is mounted on this engine. Steam is the power element for the Bury compressor, which is a horizontal single-crank machine—all cylinders being arranged in tandem, first the steam cylinder next to the crank and beyond the first and second stages, respectively, for the compression of air. The cylinder sizes are, steam 8 in., air 5 in. and 1½ in. dia. all with an 8-in. stroke. An intercooler and after-cooler is supplied with all connections, lubricator and governor. In connection with the usual type of centrifugal ball-governor there is an automatic device linked-up with the discharge of the last stage, thus the machine may be controlled by the pressure of air built up in the tank.

On the engine platform level, aft of the boiler are the crew quarters. The deck and engine crew are Chinese and it is reported that they have proved to be very good workers. The steering-engine is steam and turns the rudder through gearing and a quadrant.

Completion of the conversion was delayed beyond the time originally set as much more work was actually performed than was at first contemplated, but the owners now have a splendidly equipped, well powered efficient little carrier for their raw product. All machinery and outfit is A-1 to pass the Bureau's highest class and her chief-engineer, Mr. Barnes, is enthusiastic as to the entire engine-room.

In her trial trip Mr. Parks, general-manager of the Vulcan Iron Works, had full charge and everything went off satisfactorily, excepting some trouble with the steering gear. She made 2 5/8 nautical miles in 15 minutes and 30 seconds against a slight ebb tide. This is equivalent to a speed of 10.1 knots or in slack water 10.25 knots. Her mean draft, however, was only 12 ft. —equivalent to a displacement of 2,924 tons. Fully loaded her mean draft will be 14 ft. 3 in., displacement 3,525 tons. The average r.p.m. was 192.5, three-bladed turbine propellers of 8 ft. diameter and 6 ft. 5 in. pitch being fitted. These propellers are of manganese bronze designed by Mr. Ebsen, consulting turbine and propulsion en-



Engine-room of the "Bacoi," showing new power installation

gineer for the Vulcan Works, and made at W. A. Fletcher's plant in Hoboken. Chadburn's telegraphs were mounted at the control station and Elliott twin basket fuel-oil strainers were provided in the delivery-line to the engine fuel-pumps.

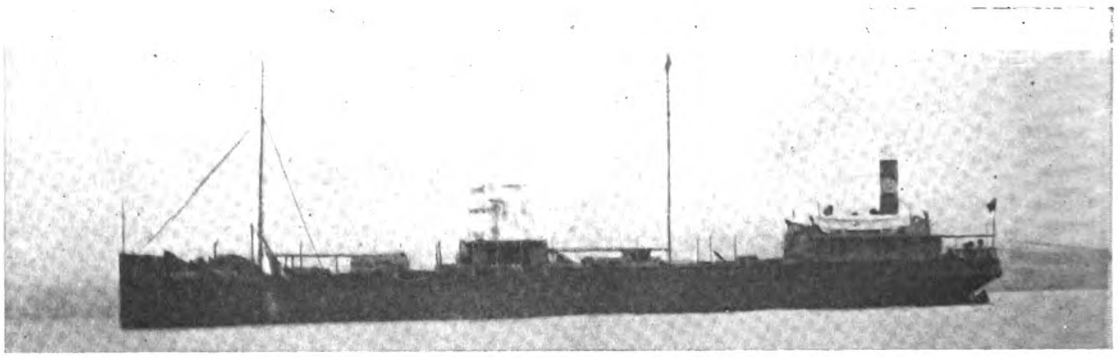
Her displacement is figured at 3,525 tons so that her efficiency or ratio of net cargo to displacement loaded is 53%. This is assuming 300 tons for fuel, feed-water and stores. The total capacity of fuel will be over 500 tons, but on the return trip 250 tons would be on board at Shanghai.

Her owners have tentatively considered equipping her engine-room with electric auxiliaries so that the boiler may be entirely shut-down while at sea. This is a most logical step inasmuch as about 300 days a year will be saved in the operation of the boiler and about three-fourths of the fuel now due to be burned under the boiler will be saved. This will amount to $10,000 to $12,000 per year alone. Readers of "Motorship" will recall the disproportionately large amount of oil consumed in this manner under the auxiliary boiler on the M.S. "Songvaar" in comparison with the amount required to operate the main Diesel-engine of 1,600 i.h.p. Truly the Diesel-electric generator and motor-driven auxiliaries have an enormous field of application.

It is gratifying to note that the "Bacoi's" first voyage for her new owners has already begun. She left Philadelphia about March 5th with a full cargo of kerosene and fuel-oil for Alexandria, Egypt, whence she will no doubt proceed through the Suez Canal and the Indian Ocean to China. The designs and specifications as well as the superintendence of the conversion work was performed by Kindlund & Drake, marine architects and engineers, who have been studying the requirements and practices in motorship work. They were, in fact, the designers and consulting firm in connection with the Vacuum Oil Co.'s tanker "Bayonne."

In addition to the "Bacoi" there are two more motorships in the yard of the Vulcan Iron Works, namely the "Astmahco III" and "Astmahco IV"—each having McIntosh & Seymour Diesel engines installed. The latter ship has just run trials.

Incidentally, the Vulcan Ironworks are anxious to witness the development of the Diesel-electric drive. This proposition to the careful student and one who keeps abreast of the march of progress is full of endless possibilities of which it is safe to say our present knowledge is quite limited.



The re-conditioned motorship "Bacoi," now powered with twin 500 shaft h.p. McIntosh & Seymour four-cycle Diesel engines

Electricity Applied to Ship Auxiliaries

Extract from Paper Presented at the Joint Meeting of the N. Y. Section of the American Institute of Electrical Engineers and the Metropolitan Section of the American Society of Mechanical Engineers, New York

BY H. L. HIBBARD

(Continued from page 220, March, 1921, issue)

Engine Room Auxiliaries. As an example of the engine room auxiliaries which are included in a large oil-engine driven vessel, we give below a list of those supplied on one of our latest motorships, the *Cubore*, of 11,500 tons d.w.c.

Deck Machinery. The deck machinery equipments, consisting of windlass, winches, capstan and steering-gear, may be considered separately to advantage.

Windlass. For the windlass equipment a watertight motor is essential and a manually operated drum controller, if installed on and operated from the deck. Frequently, however, control equipments are provided non-watertight and installed below deck with shaft extensions through stuffing box, or a contactor equipment remotely controlled with small watertight master on the deck and non-watertight automatic panel below deck. A compound wound motor can be used to the best advantage usually for the anchor windlass, particularly when of the spur-geared type, and provisions must be made in the control for stalling the motor on any controller point in case of fouling the anchor on the bottom or jamming of the gear.

Deck Winch. The auxiliary upon which probably more thought and study is being given at the present time from an electrical standpoint, than any other on shipboard, is the cargo deck-winch. This is an especially important piece of machinery on a vessel handling miscellaneous cargo, and reliability of operation, and range of speed control in both hoisting and lowering, are of prime consideration.

Much discussion has been had of late with regard to the exact type of control to be furnished for deck winches and the results to be accomplished. One manufacturer is strongly advocating at the present time, the electrically operated winch but provided with mechanical load lowering brake in place of the customary dynamic electric lowering control. While differences of opinion naturally exist on these details, one point is obvious; that the ideal electric winch is one which provides as nearly as practicable, a straight horsepower curve, accommodating its speed automatically to the value of the load and permitting the handling of light and heavy loads without the necessity of changing gears; also that it gives in lowering as near as practicable, corresponding range of speeds for heavy and light loads down to the empty hook. And it must be borne in mind that time gained in the hoisting and lowering of the empty hook is that much clear gain in loading and unloading the vessel.

In the case of deck winch equipments and anchor windlass as well, it is the practise to provide a mechanical brake on the motor shaft, electrically operated, to prevent falling of the load in case of failure of voltage.

An arrangement of control for the deck winches which has been used to some extent and was recently illustrated in the cases of the British motorship *La Paz*, provides a small deck-housing between or adjacent to the hatches and in the center of a group of winches. In this small deck-housing is placed the main controlling apparatus of the contactor type, as well as the rheostats all of open construction. At the winch itself is provided a small watertight master controller carrying contacts only for the operation of the contactors within the deck housing. This arrangement we believe is worthy of serious consideration as it groups the apparatus together to advantage, makes the apparatus readily accessible, and permits of good ventilation to the rheostats, thus permitting less capacity and smaller resistances.

Capstans. Capstan equipments, where used, are frequently so arranged as to permit installation of the driving motor in a compartment be-

ENGINE-ROOM AUXILIARIES OF BETHLEHEM STEEL CO.'S MOTORSHIP "CUBORE"

Auxiliary	No.	H.P.	Location	Motors Type	Motors Open or en.	Control Type	Control Open or en.
Fresh Water Pump	1	5	Floor	Hor.	Encl. Vent	Mag.	Encl.
Turning Gear	1	20	"	"	"	Mult. Switch	"
Booster Compressor	1	25	Platform	Ver.	Open	Mag.	"
Refrigerator	2	5	"	Hor.	"	Hand Start	"
Oil Transfer Pump	1	3	Floor	"	Encl. Vent.	Mag.	"
Steering Gear	1	25	Steer Room	"	Encl.	Spec.	"
Circulating Pump	2	25	Floor	Hor.	Encl. Vent	Mag.	Encl.
Lubricating Oil Pump	1	7½	"	"	"	"	"
200-Ton Ballast Pump	1	15	"	"	"	"	"
Bilge Pump	1	15	"	Ver.	"	"	"
Air Compressor	2	125	Platform	"	Open	"	Open
500-Ton Ballast Pump	1	50	Floor	Hor.	Encl. Vent.	"	Encl.
Lub. Oil Purifier	2	1	For'd Blk.	"	Encl.	Hand Start	Open
Fuel Oil Pump	2	3½	Floor	Hor.	Encl.	Mag.	Encl.
Sanitary Pump	1	7½	"	Hor.	Encl. Vent.	Mag.	Encl.
Lathe	1	1½	Platform	"	Open	Mag.	Encl.
Grinder	1	3	"	"	"	Hand Star	Open
Drill	1	2	"	"	Open	"	"
Generator	2	100 k. w.	Floor	Oil Engine driven			
Generator (Emergency Set)	1	100 k. w.	"	Geared steam turbine driven			

low decks and thus allowing an open or at least a self-ventilated motor, which is usually furnished heavily compound wound to provide the varying torque characteristics necessary with this equipment. The control, in its simplest form, may be a plain starting hand operated or push button controller, but the best practise provides stalling features and dynamic or armature shunt control on one or more points in either direction for use in paying out cable. The motors should be usually provided with an electrically operated mechanical brake as the drive is often through gearing efficient enough to permit overhauling.

Steering Gear. The early stages of development of the electric drive as applied to steering gears, is quite generally covered by the writer's paper before the A. I. E. E. in May 1914, which describes in detail the direct application of electric-drive where a motor is geared directly to the transmission, frequently of the screw gear type. With this arrangement the motor is operated by a contactor panel remotely controlled from the bridge, usually on the non-follow-up system, although electrical follow-up control has been designed and some times employed.

(*To be continued in our May issue*)

ELECTRIC AUXILIARIES OF MOTORSHIP "TOSCA"

In our article on the motorship "Tosca" published in our January issue, we stated that the electrical winches were supplied by Messrs. Figge & Co. of Haarlem. This is a typographical error, as the correct spelling of the name is "Figee."

Electric Propulsion of Ships

Advantages of the Diesel-Electric System

BY W. E. THAU* General Engineer, Westinghouse Elec. & Mfg. Co.

THE following types and arrangement of power drives have been applied with more or less success to ships:—

1. Direct-connected reciprocating steam-engine.
2. Direct-connected turbine.
3. Geared turbine.
4. Turbine-electric with direct-connected motor.
5. Turbine-electric with geared motor.
6. Internal-combustion engine, direct connected.
7. Internal-combustion engine, geared.
8. Internal-combustion engine, or Diesel-electric. using direct-connected motors.

From an economic standpoint, the direct-connected Diesel drive is far superior to any type of steam drive, and is certain to see an era of prosperity. However, when compared with the Diesel-electric drive, the economy advantages of the direct Diesel drive are small and in the case of long runs, the additional weight has a slight disadvantage.

The ordinary internal-combustion engine using gears will probably see very little more development under present conditions. The internal-combustion engine or Diesel electric drive using direct-connected motors offers possibilities superior to those of any other type of drive.

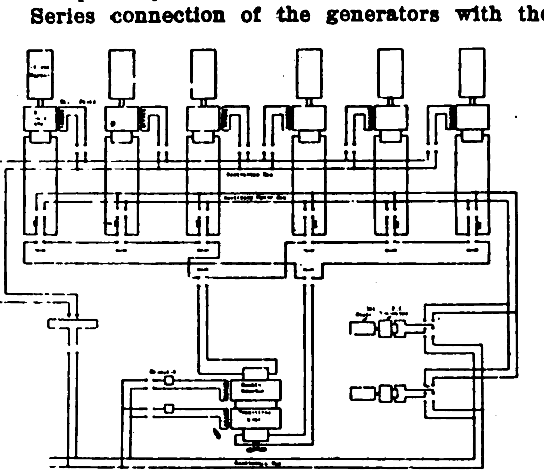
Reliability should not be sacrificed for any other consideration. Reliability necessitates close adherence to rugged and thoroughly proven apparatus which must of necessity stand more or less abuse without danger of failure. The machinery must operate continuously for days and possibly for months without shutting down, and must be simple within reason and thoroughly understood by the operators. Economy, cost, weight space, etc., are important in that they determine the relative earning capacity of the ship.

With the Diesel-electric drive, the electrical equipment is of the d-c. type, because of its flexibility, ease of speed control and simple requirements of the engine governors. If alternating current were used with Diesel-electric drive, the engine governors would have to be highly refined as it would be necessary to operate the generators in parallel; whereas with direct current, the generators may be operated in series, thus permitting relatively simple engine governors. Even with parallel operation of the d-c. generators, the governor problem offers no difficulty, however, there are other decided advantages in favor of the series operation. The propeller speed is varied any amount from zero to a maximum in either direction, without opening a single circuit, by merely adjusting the generator voltage by means of a simple field rheostat, the engines always operating at constant speed.

For ships up to 6,000 h.p., (the larger sizes having twin screws) the Diesel-electric types of propulsion possesses marked advantages over all other types. With this type of drive, any reasonable number of generating units may be used, independent of the arrangement of the propellers. It is, therefore, possible to use a number of relatively small reliable, high-speed Diesel-engines driving direct-connected d-c. generators. By using a number of the small units, the disadvantages of large Diesel-engines are obviated. Aside from the reliability thus obtained, there is the added important advantage of flexibility with regard to reserve power, and as will be shown later, this advantage is possessed in an extreme degree only by the Diesel-electric drive.

The electrical apparatus is well understood, thoroughly tried out, and there is consequently no question as to its reliability. The motors are separately excited at constant potential in one direction while the generators are supplied with excitation through a reversing field rheostat so that any desired voltage may be obtained from zero to the maximum in either direction. With this arrangement, the speed of the motors is directly proportional to the voltage of the generators. Therefore, the control is as simple as could possibly be desired.

Series connection of the generators with the motors interposed to reduce the ground voltage to a minimum has certain advantages over parallel connection of generators. For the purpose of discussion, let us assume a single-screw drive consisting of six generators and a motor consisting of two separate units mounted on the same shaft. Electrically, the machines would be arranged in series as follows: Three generators, one motor unit, three generators, one motor unit. On the basis of 250-volt generators, the maximum ground voltage would be 750 volts, although from the standpoint of current, the system has all the advantages of a 1,500-volt circuit. This arrangement of generators and motors is independent of the number of either, and is particularly advantageous in case the number of generators is uneven, such as five generators and two motors. Furthermore, the motor units may be on different screws as in the case of a twin-screw drive. Even in the latter case, independent control of the port and starboard screws can be obtained. However, with the same or opposite rotation of the screws, the amount of speed difference obtainable is limited, although wholly within requirements.



Diesel—Electric Drive, Schematic Arrangement Electrical Connections

With the series arrangement, more power can be obtained from remaining generator units in case of failure of one or more generator units, without providing excess capacity in the motors. The reason for this is that each of the remaining generators can be operated at normal voltage and the field of the motors weakened to increase the propeller speed to a value which will load the remaining generator units to their capacity.

In the way of a summary, the following table of comparison of the various principal drives will be of interest. In arriving at the figures given, all items of machinery and supplies necessary to the main propelling machinery were considered; foundations, water, fuel, etc., were taken into account. However, it was necessary in some cases to make certain assumptions, but an effort was made to place such assumptions on the conservative side, so as not to show an exaggerated comparison. Further, certain major figures are at great variance in practise, and the table is, therefore, given as indicative of the trend of this comparison rather than actual proportions. The figures for turbine electric drive and geared turbine drive are based on the same steam conditions.

The figures are based on a 3,000 h.p. ship operating over a 4,000 mile course at a speed of 11 knots, and making a total of 14 single trips per year. The geared-turbine ship is taken as unity.

Drive	Fuel Consumption	Machinery Weight
Geared turbine	1	1
Turbine electric	1.06	1.05 to 1.10
Direct-connected Diesel	0.49	1.10 to 1.25
Diesel-electric	0.57	0.75

*Extract from paper presented at the Joint Meeting of the N. Y. Section of the American Institute of Electrical Engineers and the Metropolitan Section of the American Society of Mechanical Engineers, New York, N. Y., January 28, 1921.

Air-Injection or Mechanical-Injection

A Technical Treatise on a Subject of Great Importance to Diesel-Engine Builders

BY J. L. CHALONER

Part III.

[We have been fortunate enough to secure Mr. Chaloner's exclusive services, and his valuable articles on Diesel-engine subjects will only be found in "Motorship."—*Editor.*]

(*Continued from page 133, February issue*)

IT will be observed that for a heavy fuel, such as is suitable for a marine oil-engine, the vapourization temperature range is about 400° F., which value will make it quite clear, how difficult it is to evaporate the whole of the fuel charge, before a partial admixture takes place with the more readily evaporated portion of the fuel. Again important it is to have maximum degree of vapourization, to ensure a homogeneous combustible mixture. It is essential therefore, that a maximum amount of heat should be transferred from the highly compressed air in the combustion-space to the fuel in the shortest possible time. This condition becomes absolutely imperative with heavy fuels, such as are now forming the main fuel supplies for oil-engines.

In the previous article on "Notes on Air-Injection for high pressure oil-engines," in the August 1920 number of "Motorship," attention was already drawn to the following important observation:—

With the air-injection it can be assumed that each globule is surrounded by a corresponding layer of compressed-air, assuming of course, that the air is acting as an efficacious atomizing agent. As the size of globule, with increasing atomizing pressure, decreases, the depth of the surrounding layer of compressed air will at least remain of the same depth as in the previous instance. The relative volume of air to oil will, therefore, increase, and either more heat per globule of the oil charge will be necessary to penetrate the larger volume of compressed-air in the same time, so that the same amount of heat is given to the oil particle, or otherwise it will take a longer time for the requisite amount of heat to be imparted to the oil charge to complete vapourization. As the time element plays a very important factor in the degree of combustion of the fuel charge, it will be clear, how essential it is to transfer the requisite amount of heat from the highly compressed-air charge to the fuel in the desired space of time.

It is generally accepted that partial dissociation will take place when vaporization of the fuel takes place in the fuel-valve and combustion-chamber However, the effect of pressure on such chemical reaction is not yet known sufficiently well, to draw any definite deductions. This point will be discussed in detail in another article dealing with the suitability of fuel-oils.

There is however, another aspect of the problem. The fuel-valve temperature in a Diesel-engine is on the average about 650° F. It has been determined from practical tests, that the amount of oil in the fuel-valve chamber below the level at which the fuel enters the valve-casing proper, should not exceed 30 to 40% of the total weight of oil required for any particular charge. This surplus and the major portion of the next charge should be distributed in the pulverizer as near to the fuel valve face, as practically possible, in order to get the full benefit of pre-heating.

Such a distribution, however, would lead to an insufficient atomization. On the other hand, a distribution of the fuel in the compressed-air in the fuel-valve proper would diminish the pre-heating effect. Figs. No. 21 and 22 show light-load and full-load cards, when the greater portion of the charge is as near to the fuel-valve opening, whereas in Figs. 23 and 24 care is taken to have the fuel-charge well distributed over the air. The effect of the compressed-air is quite apparent, although it is admitted at the same time that this point is not of such material importance, when using as fuel an oil approaching in quality that of a gas-oil or solar-oil.

To-day the aim of every designer is to construct an engine which will run satisfactorily on a residuum such as is burnt under boilers or in furnaces. It is with particular reference to such fuels that attention is drawn to the importance of favourable thermal conditions, not only in the combustion-chamber proper, but also already in the fuel-valve casing. Only under such conditions will it be possible to vapourize the oil-charge sufficiently to product an effective combustible mixture.

With mechanical-injection the conditions are fundamentally more favourable. The absence of any air will prevent any possible formation of a combustible or even explosive mixture with the more inflammable portion of the fuel charge, which, if in existence, would produce a spray, less homogeneous than desirable, on entering the combustion-chamber.

It is suggested that particularly for heavy fuels the mechanical injection method offers more favorable conditions to give a high degree of combustion, especially in high-powered units.

3. Combustible Mixtures

By a suitable combustible mixture it is understood, that a requisite amount of air is mixed with the charge of fuel to form a mixture which under favorable thermal conditions will readily and completely burn without leaving any appreciable residue in the combustion-chamber. With every class of fuel, an amount larger than the theoretically calculated amount, is required to burn any specific quantity of fuel.

In the recent article on "Air-Injection for high-pressure oil-engines" several tables and data are quoted giving the excess air co-efficient for different conditions with regard to the air injection method, and the reader is referred to the "Motorship" (July, August, and September, 1920) for reference.

From tests taken over a wide range of powers and types of engines it has been observed, that about 4% of the total available combustion or "Cycle" air is provided by the compressed-air, following the fuel charge into the combustion chamber, when considering normal load (full load) conditions. The air excess co-efficient is about 1.4, and varies with the load, and also to a certain extent with the size of cylinder. Such an average curve is shown in Fig. 25.

With mechanical-injection the co-efficient does not vary at the same rate, and a corresponding curve is graphed on Fig. 25, the size of cylinder and load being as far as possible very similar.

In the former case the data were calculated from the exhaust-gas analysis, whereas in the latter the chemical composition of the fuel to-

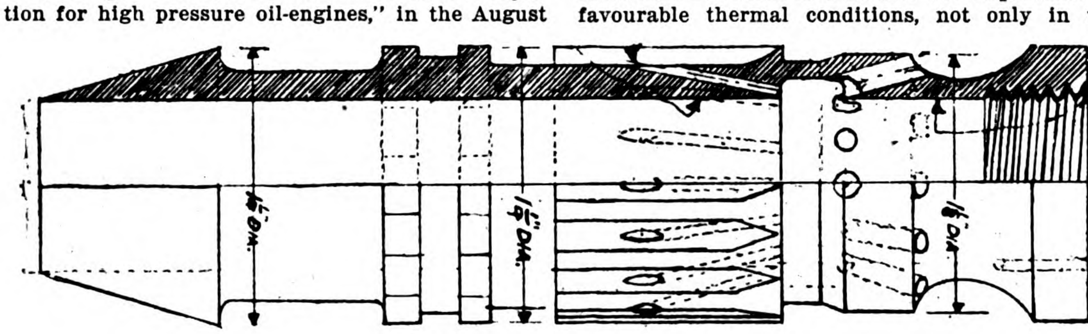


Fig. 18

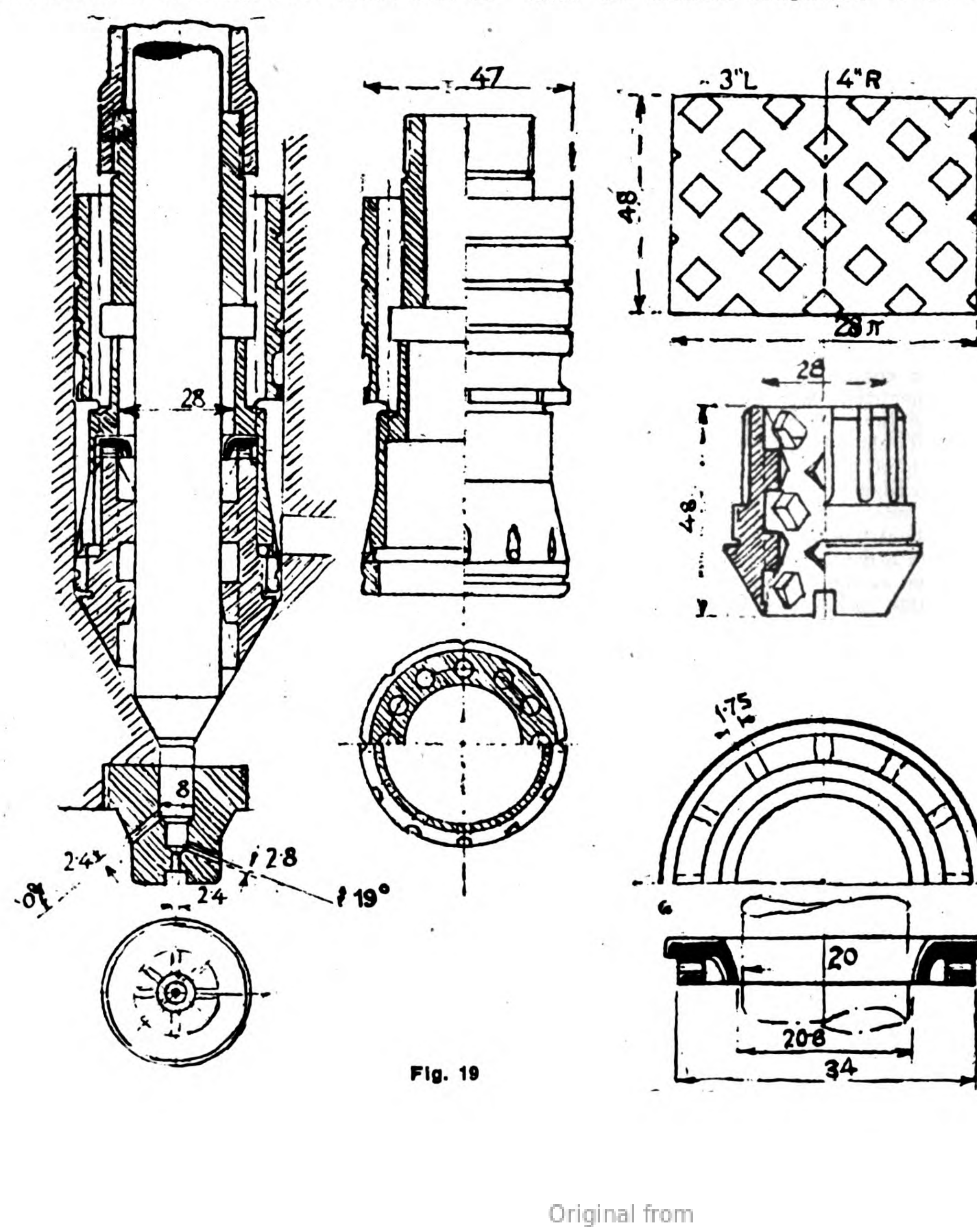


Fig. 19

gether with the measured quantity of the total air were utilized for the purpose.

As has already been stated, turbulence is essential in addition to a high degree of atomization to obtain a homogeneous mixture, and it has been stated that in this respect the mechanical-injection method has great disadvantages relative to the rival system. But it is suggested that a suitable design can be evolved, which together with the natural properties of a fuel changing rapidly from a liquid state into a gaseous state, will produce that degree of turbulence as is required to obtain a high degree of combustion.

4. Dissociation of Mixture

It is too previous to discuss the dissociation of a combustible mixture for the simple reason, that so far very little is known as to what takes place actually inside the cylinder. It would therefore be fruitless to draw any comparison between a mechanically injected and air-injected charge.

In a recent discourse by Prof. Chas. Lucke in "Motorship" attention was drawn to this point, and there is here a very wide field where a co-operation between chemist and technical engineer would result in the recording of invaluable information with regard to the combustion process inside an oil-engine cylinder.

The writer has from time to time impressed the industry with the fact that the oil-gas formation of a fuel is of primary importance to the more accurate understanding both of the preliminary and actual stages of combustion. It is so far quite agreed upon, that partial or even untimely dissociation is the point to guard against.

In the article on the "Progress in Marine Diesel-Engine Building at Krupp During the War" by Otto Alt, the author quotes on pages 694 and 695 of "Motorship" (August issue) several references, and the reader is referred to this particular article for further information on this subject.

The comparatively high temperatures of the fuel-valve and casing, the presence of compressed-air (the pressure of the air does not materially affect the resultant condition) are two factors conducive to partial dissociation before the fuel-valve opens. During such dissociation the more volatile fractions may become liberated and form a mixture which on entering the combustion-chamber would have a tendency to burn more in form of an explosion than combustion.

The injection-air has a cooling effect on the entering charge, and to a certain extent counter balances this "explosive" tendency, although at the same time it disturbs the homogenity of the mixture, to a degree proportional to the pressure difference between the combustion-chamber and the fuel-valve casing. It will be apparent, that the effect increases with conditions approaching full load.

Whilst there is a similar effect on the charge injected under mechanical-pressure, the cooling effect does not exist, and there is under certain thermal conditions of the fuel-valve casing a correspondingly greater tendency to burn in form of an instantaneous combustion. The correct adjustment of the thermal conditions of the fuel-valve casing is therefore of considerable importance with mechanical-injection systems, to minimize this high initial rate of combuston.

5. Combustion

Whilst the temperature of the "cycle-air" charge in the combustion-chamber governs the ignition of the charge, it is not clear what relation exists between the final compression-pressure temperature and the ignition point of the fuel. The fact that with mechanical-injection a lower compression-pressure can be used, does not bear on the subject, but simply illustrates the retarding effect, which the compressed-air has on the rate of combustion during its expansion. The compressed-air is said to give back a certain amount of energy absorbed in the air-compressor on expanding into the combustion-chamber. Experiments, however, have shown that at the most only about 0.75% of the total available energy is usefully employed.

On the other hand, mechanical-injection permits of an accelerated combustion and the thermal-efficiency equation shows that the efficiency increases with lower cut-off ratios, provided that the time element is of sufficient duration to allow for complete combustion. The following table gives a series of data, confirming this point.

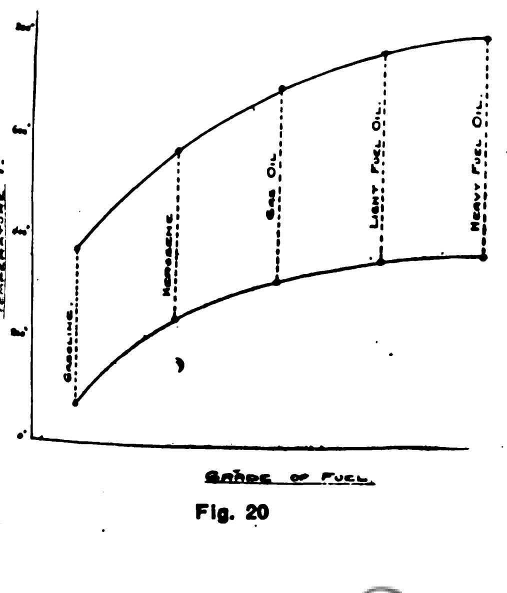


Fig. 20

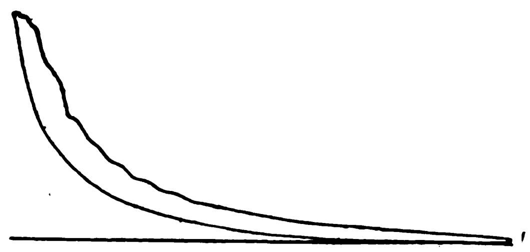


Fig 21

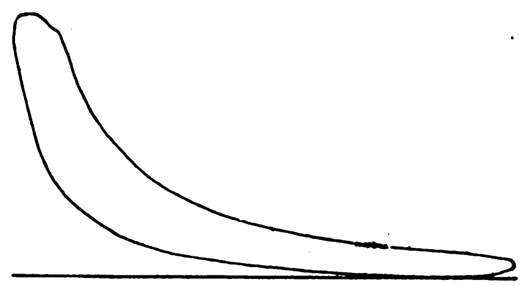


Fig. 22

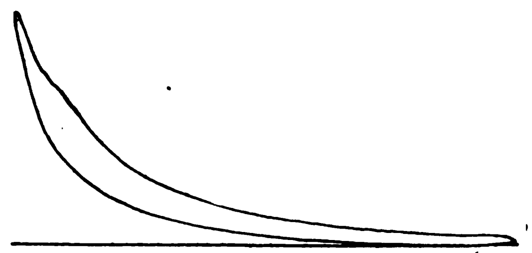


Fig. 23

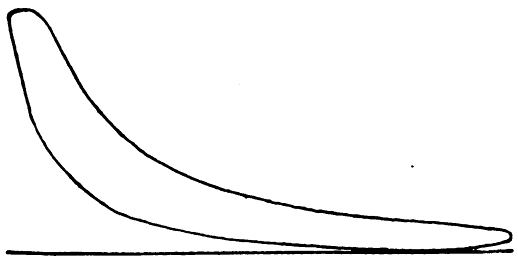


Fig. 24

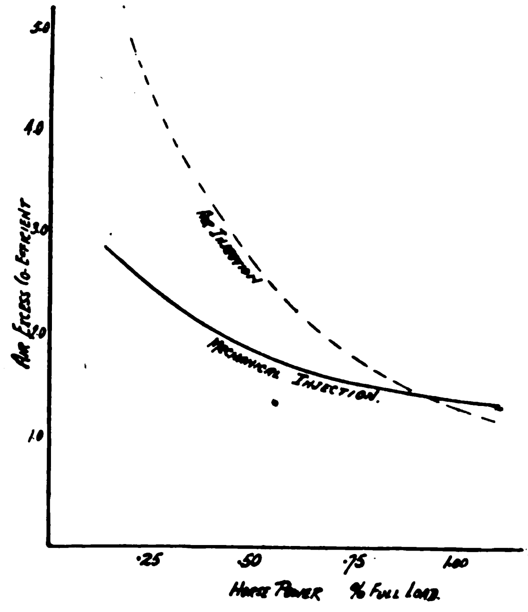


Fig. 25

The degree of combustion and the after-burning effect have occupied the careful attention of designers and there is no doubt that the general running of heavy-oil engines can be improved considerably.

For comparative purposes the following tables have been compiled, representing average results for a large number of tests with both methods. Unfortunately the fuels used were not the same, or even in some cases similar, but the data quoted refer to similar powers developed per cylinder, being 125 h.p. in the case of air-injection, and 120 h.p. for the mechanical type.

The conditions for complete combustion specify that each particle of oil is to be brought in contact with the requisite amount of oxygen, and that combustion should commence at a pre-determined moment. After burning in pockets inside the combustion-chamber, abnormal temperatures owing to irregular castings or insufficient cooling, faulty scavenging are some of the main factors which will assist in creating unfavorable conditions irrespective of it being an air or mechanical system.

Timing of the combustion depends in the air-injection method on the correct distribution of the fuel-charge around the valve-seating, and numerous devices have been suggested and introduced, which although more or less effective, do not tend towards simplicity of the construction of those parts, which are somewhat inaccessible from the point of running adjustments. The valve must be designed to allow the fuel to enter the combustion-chamber in front of the injection-air. This is essential as the resultant conditions govern the temperature and size of the ignition-flame.

The air-excess co-efficient has already been discussed and more or less identical conditions exist for both systems. The additional amount of air which is added to the cycle-air, when using the compressed-air method only represents about 3.5% to 4.0% of the total amount of air. Assuming an air-excess co-efficient of 1.45, then the above percentage would alter its value to about 1.50.

Relation between exhaust temperatures and air-excess values have been compared, but the difficulties in getting representative samples of exhaust-gases in connection with two-stroke engines have made the available data somewhat valueless for the present.

(*To be continued*)

Load	¼	½	¾	Full
Cut-off Ratio (Calculated)	1.81	2.20	2.84	3.38
Cut-off Ratio (measured from indicator diagram)	1.39	1.56	2.11	2.54
Efficiency (thermal)	56.0%	55.7%	52.4%	51.4%

PERCENTAGE OF COMBUSTION COMPLETED

Position of piston during power-stroke	Air-injection	Mechanical-injection
¼ stroke	87.5%	85.0%
½ stroke	6.0%	8.5%
¾ stroke	4.5%	3.5%
end of stroke	2.0%	....
Fuel Used	Light fuel-oils 0.89 sp. gr.	Light fuel-oils 0.915 sp. gr.

Joseph W. Powell and the Diesel Engine

Discrediting the Importance of Motorships

(Contributed)

IN the leading article of *Marine Journal* of February 26th there are quoted some remarks of Mr. J. W. Powell, former Vice-President of the Bethlehem Shipbuilding Corporation, which were recently made before the National Merchant Marine Association and in which he discredits the economic importance of the Diesel engine as a prime mover for merchant vessels.

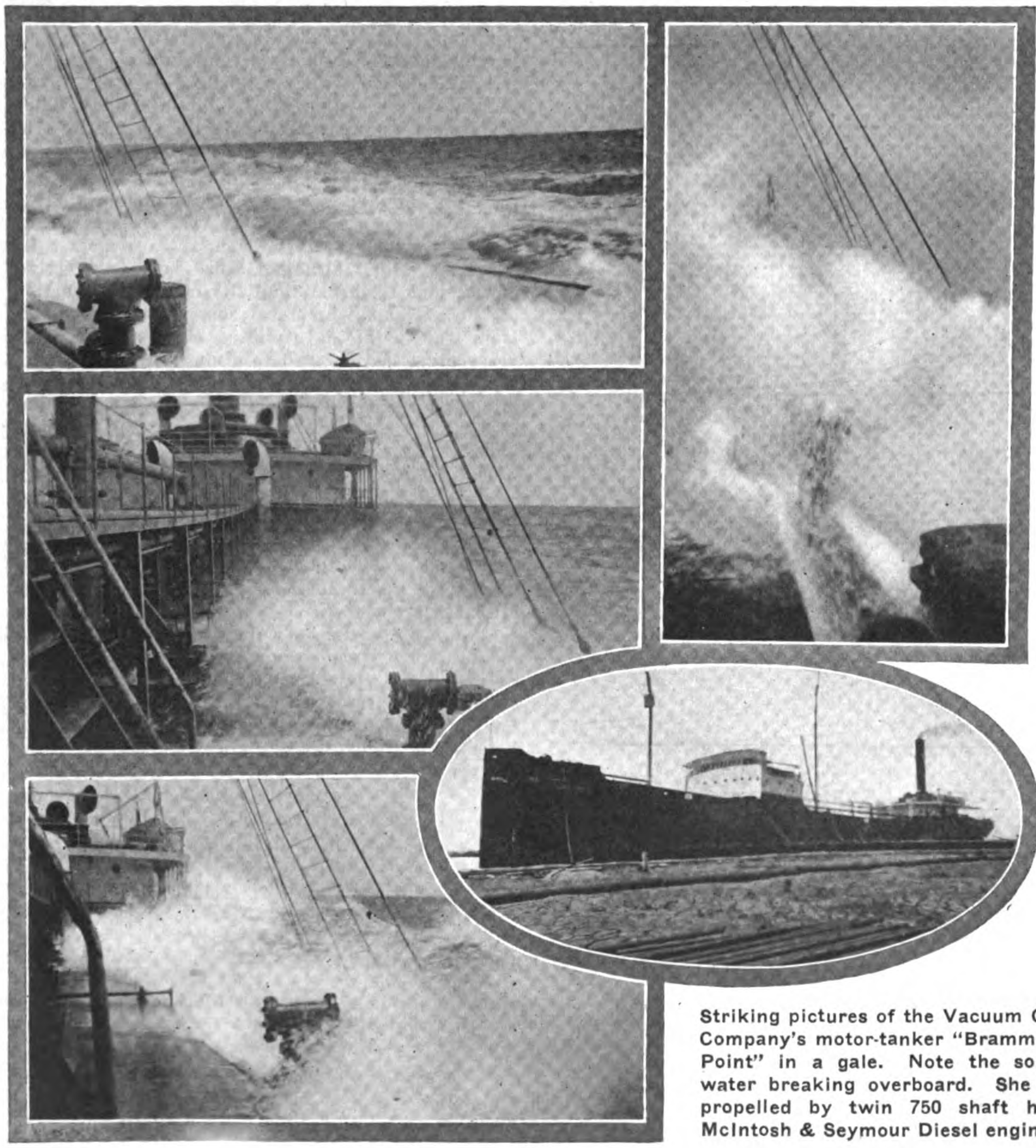
The reasons for Mr. Powell's present attitude may be found by referring to the period when the Bethlehem Corporation was developing a new marine Diesel engine of their own design, from which great things were expected. At that time Mr. Powell frequently and somewhat enthusiastically expressed his belief in the future of the marine Diesel-engine and particularly in the future of their new design. As the active head of the Bethlehem shipbuilding interests it is not unlikely that Mr. Powell was responsible for Mr. Schwab's optimism when the former Director-General of the Emergency Fleet gave to the press certain extravagant claims in reference to the Bethlehem Diesel-engine then being installed in the "Cubore," which claims were freely criticised by technical papers abroad. It will be remembered that remarkable economy was claimed as well as various other points of superiority over anything previously built. The designer of this engine was also reported in the press as having made the following explanation of the superior features involved in his design:

"Europeans failed in the designing of Diesel-engines for American operation because their creations were not suited to American operating conditions, especially those prevailing in American ships' engine-rooms, where the crew was not used to a multitude of fine adjustments and delicate mechanism. The secret of the success of any design, so far as its operation by Americans is concerned, is that it be made with the fewest possible adjustments. Not only that, but it ought to remove the possibility of an engineer's adjusting it any other way—if he can do so. That is where our European friends failed when it came to making engines for American operation."

The announcement was next made that the Bethlehem Corporation was immediately beginning the construction of four more large motorships to be equipped with their new and exclusive design of Diesel engine.

After the ship in which their first engine was installed had been in service a few months, notable changes in Bethlehem's organization and plans took place. It has been reported from all directions that the three new vessels will be fitted with steam propelling machinery and in the meantime Mr. Powell, no longer vice-president of the Bethlehem Coporation, has become fully qualified as an authority on the disadvantages of the Diesel motor for merchant-vessels; all of which is very unfortunate, but not sufficient to discount the uniformly successful experience of foreign owners of large fleets of big motorships that have seen years of service, nor that of several American owners who operated Scandinavian motorships of the first-class under charter during the War, also smaller vessels with American built engines, and who are convinced that the steamship cannot compete with the vastly more economical and equally reliable motorship. The evidently unfortunate experience of the Bethlehem Corporation, who in their design wandered from accepted marine engineering practices, should not be taken as a criterion in deciding the economic status of the hazard incurred in disregarding the accumulated experience of successful builders of marine motorship but rather as an illustration of the Diesel machinery, which policy caused the downfall of several other engines in the past. It is time that Operators and Owners realized that the only successful marine Diesel installations in large ships are those being produced by firms with years of experience in such work or the licensees of such firms, who pay for and are guided by such experience. Had Mr. Powell acquired the manufacturing rights for some first-class marine Diesel construction there would have undoubtedly been several additional American motorships approaching completion and his opinions of their worth would not be those of an apologist.

[In our issue of February, we indicated that criticism of the Bethlehem design was a little premature because no authentic information was available; but, further information regarding the operation of this experimental ship is now to hand.—*Editor.*]



Striking pictures of the Vacuum Oil Company's motor-tanker "Brammell Point" in a gale. Note the solid water breaking overboard. She is propelled by twin 750 shaft h.p. McIntosh & Seymour Diesel engines

QUESTION OF THE TWO-CYCLE MECHANICAL INJECTION ENGINE

A paper on "Oil Engine Progress," by Mr. J. L. Chaloner was recently read before the Diesel Engine Users Association and was followed by an instructive discussion. The author referred in very favorable terms to the position of the British internal-combustion engine industry and the lines on which it was likely to develop in relation to Continental and American competition. He gave figures in support of a statement that of the high-pressure engines in this country 25 per cent worked on the mechanical-injection principle and that 50 per cent. were two-cycle gines, 96 per cent worked on the mechanical-in-engines. In the case of medium-pressure enjection principle while 58 per cent. were two-cycle engines. This data showed the tendency towards the two-cycle design and the position which the mechanical-injection principle already held with regard to the heavy-oil engine. He urged the imperative necessity of further flexibility on the part of the engines in order that heavy-grade oils might be used to a greater extent for internal-combustion engines. The efforts made in Great Britain to simplify oil-engine construction had met with greater success than either on the continent or in the United States.

Various methods of fuel atomization and of air, mechanical, and gas-pressure injection were described and compared. Mr. Chaloner considered that the gas-pressure system might be discarded as a practical solution of fuel-injection. The principle involved was only suitable for light fuels and the mechanical difficulties were many. The greater portion of the charge was in contact with burnt gases which made it difficult to bring the combustion-air into contact with the fuel within the limited time of the combustion period.

The important part which turbulence played in the combustion process had been fully realized and it had been suggested that with mechanical-injection a very much lower degree of turbulence was only possible. The general tendency of introducing long-stroke designs for marine and other slow-running engines produced conditions favorable to the application of mechanical-injection.

The author did not suggest that the problem of mechanical-injection had been solved, but the results obtained so far showed that satisfactory progress was being made. The prospects were great and the possibility of a two-stroke engine without any mechanically-controlled valves justified the closest attention by engineers who were anxious to further the progress of the oil engine. In the opinion of the author the two-cycle mechanical-injection engine would materially assist in bringing the various types into line.

SWEDISH MOTORSHIPS FOR SPAIN

Alvaro Rodrigney, of Teneriffe, Spain, has taken delivery of two small steel motorships recently built in Sweden by the Aktiebolaget Vaxholms varvet, of Ramso. They are named "Santa Ursula" and "Sancho II" and both are of 318 tons gross. Each is propelled by a four-cylinder 320 b.h.p. Bolinder surface-ignition oil-engine.

Our Readers' Opinions

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed)

SENATOR WESLEY L. JONES AND MOTORSHIPS

To the Editor of "Motorship,"
Sir—

As a layman I feel that Diesel-engined motorship construction is worthy of the most careful consideration. It is impossible to do anything in a legislative way at this session, if at all; but I feel confident that after March 4, we will have a Shipping Board which will give careful consideration and take the proper action on this and all other administrative questions involving the promotion and maintenance of an adequate American merchant-marine. Certainly the wonderful strides in motorship construction in other countries justifies the matter being gone into exhaustively in the interests of our own merchant marine.

Yours very truly,
W. L. JONES,

Chairman, U. S. Senate
Committee on Commerce,
Washington, D. C.
March 1st, 1921.

ADMIRAL BENSON AND MOTORSHIPS

To the Editor of "Motorship",
Sir—

Regarding the construction of motorships you are, of course, aware of my deep interest in this matter and I am doing everything I can towards development by the United States.

Yours very truly,
W. S. BENSON,

Chairman,
U. S. Shipping Board,
Washington, D. C.
March 1st, 1921.

PLEASE ADVISE NEW SHIPPING BOARD ACCORDINGLY!

To the Editor of "Motorship",
Sir—

Admiral Benson has been kind enough to show me your letter of February 23d which demonstrates the most remarkable showing of the savings which can be effected by motorships when properly handled and when the full capacity of their tanks is made use of in order to sell bunkers on the other side. This showing is something which should be brought to the observation of American shipowners, because herein I find one of the greatest savings that the American owner can effect, particularly as the greater part of the world's oil supply is found in our own country. I think it is due to shortsightedness that our country is so sparingly represented by motorships in its fleet.

Yours very truly,
JOHN A. DONALD,

U. S. Shipping Board,
Washington, D. C.
March 8, 1921.

SIFTING CHAFF FROM CORN

To the Editor of "Motorship"
Sir:—

I should like to compliment you upon the mercurial liveliness of your journal and upon the soundness of the articles. I have been on Diesel-engine work for sixteen years and know the business, so I find it very refreshing to come across a journal written by people that understand their subject. It is only too often the case that the people who work such specialized journals merely repeat information they receive whether it be right or wrong and have not the experience to sift the chaff from the corn.

I have pleasure in enclosing herewith Post Office order for 19s/- to renew my subscription for your journal.

Yours very truly,
H. GEO. KIMBER.

13 Grosvenor Drive,
Whitley Bay,
Northumberland, England,
January 17th, 1921.

OUR READERS ACROSS THE SEA

To the Editor of "Motorship."
Sir:

I would like to say that I appreciate "Motorship" more every year and would not like to be without it. You will perhaps be surprised to hear that a great number of men connected with marine Diesels, with whom I come in contact, have not yet made the acquaintance of your worthy paper, to their own disadvantage. Wishing you every success,

Yours very truly,
(Signed) H. F. THURGOOD.

33 West Cumberland St.,
Glasgow, Scotland,
Jan. 23rd, 1921.

[Recently we have been enabled to make satisfactory arrangements regarding the distribution of "Motorship" in Great Britain, and copies are now carried on the Smith bookstalls and Wyman bookstalls at the principal railway stations. Our wholesale and retail agents are the Atlas Publishing & Distributing Co., Ltd., 21 Bride Lane, Fleet Street, London, E. C. 4. We will be glad if you will advise your friends accordingly.—*Editor.*]

ANOTHER COMPLIMENT FROM ENGLAND

To the Editor of "Motorship",
Sir—

I must congratulate you on your Paper; it certainly is first in with the news, which speaks well for your organization.

Yours very truly,
ALFRED J. WILSON,

"Blairalan,"
Woodside Rd., Sutton,
Surrey, England.

FROM AN UNEXPECTED SOURCE

To the Editor of "Motorship,"
Sir:

I have received the January and February numbers of "Motorship," and feel that I am in my glory now. Please enter the following subscriptions to "Motorship" for one year commencing with January issue to—

(Here followed the names and addresses of four new subscribers.—Editor.)

These men are all experts on turbine and steam-engines.

Yours very truly,
JOHN M. RANKIN,
Scout-Master

Boy Scouts of America,
Hampton, Va.

DESCRIPTION OF AMERICAN DIESEL PLANTS

To the Editor of "Motorship",
Sir—

In the recent February issue of your splendid magazine, in the Nordberg article, you speak about "Sometime . . . it is our intention to very fully illustrate . . . this and other Diesel factories in the U. S." I am sure others besides myself await these indirect factory visits with pleasure. It is good to see what some progressive plants are doing. I remain

Yours very truly,
C. H. DENGLER,

Irvington, N. J.

FROM A STUDENT READER

To the Editor of "Motorship",
Sir—

As a student engineer specializing on the design of Marine oil-motors I have been greatly aided by your progressive magazine. The development of the Oil Motor has been so rapid that tests, etc. are antiquated by the time they are published. I am certain that with your up-to-the-minute information that you have forwarded that development in no small measure. You and your magazine richly deserve the high opinion held by all engineers, etc. that I have met.

Yours very truly,
C. ARTHUR JACOBSON,

Schenectady, N. Y.

CRANK-PIN BOX DESIGN

To the Editor of "Motorship":
Sir:

In the last December (1920) issue of "Motorship," a very interesting article was presented by Mr. Hildebrand, on "Marine Crank-Pin Boxes." A serious defect in the ordinary crank-pin box design was explained, with mathematics accounting for bolt fracture, and a patent design described that should remedy this design error. The defect of the old, and the worth of the Hildebrand box, is immediately apparent to any thoughtful engineer; and no doubt many of this new design will be incorporated in 1921 engines.

What was puzzling me with this proposed box and also the older designs, why this same defect does not hold true, as for instance in Fig. 1 at A; and why some means is not taken from preventing the box from parting at this joint? A loose bolt here or misalignment between the two pieces is just as serious a matter, at the top of the box as at its lower face. If in the pistons reciprocating movement it develops a tendency to turn, what prevents it other than these two bolts—should this occur, and it certainly does—the bolts will still be subject to shear.

Having read that this box design is patent protected, it might be interesting to know that with a certain company that I was once connected with, a connecting-rod for a high-speed automobile-engine incorporated a rod with this spigot feature, for alignment of the cap to the rod. Fig. 2 represents the rod mentioned, the similarity in design is at once apparent. This design is at least three or more years old, and I might add the engine, which is still in daily service, on the block shows a piston-speed of 3,844 ft. per min., and develops 0.323 h.p. per cub. in. of piston-displacement, as a proof of the practicability of the design.

C. H. DENGLER.

Irvington, N. J.

P. S.—Fig. 1 is same as Fig. 1 in the original article, with the letter "A" pointing to the joint of the rod to the upper box. This I did not draw. Fig. 2 our rod design is enclosed with the article.

C. H. D.

[We have been obliged to hold-over a number of communications, including an interesting letter from Ernest V. Parker.—*Editor.*]

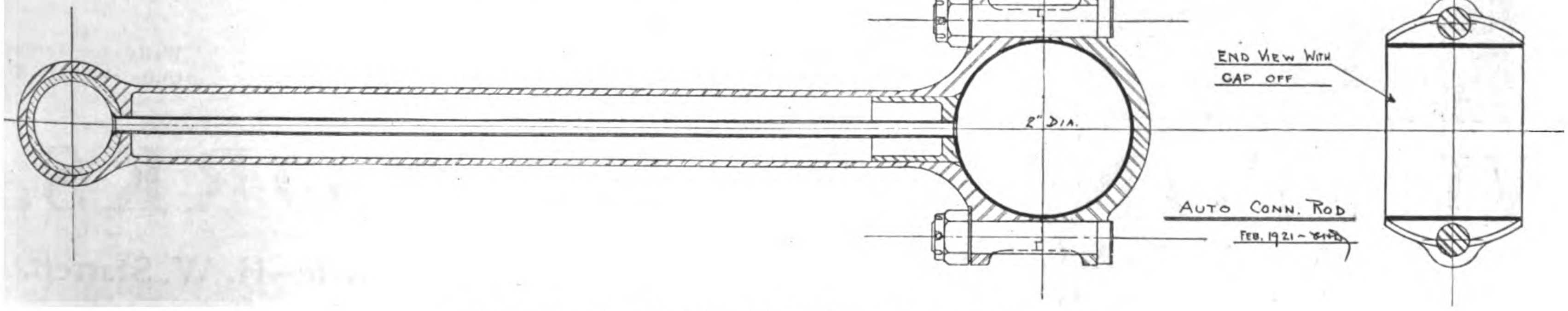


Fig. 2. Design of crankpin box referred to by Mr. Dengler.